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TRANSACTIONS

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ON THE SCENT ORGANS OF *OPSIPHANES CASSIAE LUCULLUS*, FRUHST. (LEPIDOPTERA, BRASSOLIDAE)

By H. ELTRINGHAM, M.A., D.Sc., F.Z.S.

[Read December 5th, 1928.]

PLATE I.

IN our *Transactions* for 1926, p. 367, *et seqq.*, I described the structure of a peculiar gland in the abdomen of the male *Eryphanis polyxena*, Meerb. (BRASSOLIDAE). In this insect there are no brush-organs, though there are, on the hind-wings, brands bearing special scales not, apparently, correlated with the abdominal glands. Whether these two separate organs give rise to different scents at different times, or whether their volatile products combine in the air to produce a single effect, we do not know. There is not, however, in *polyxena*, any special mechanical distributing apparatus, unless indeed the inner margin of the hind-wing acts in that capacity in relation to the lateral abdominal gland.

In 1923 an account of the scent-organs in *Opsiphanes tamarindi sikyon*, Fruhst., by J. H. Jurriaanse, appeared in *Tijdschrift voor Entomologie*, LXVI, p. 147, and a short notice of it was given in the *Entomologist*, 1924, p. 94, with a reproduction of the original text-figure.

The acquisition of suitable material has enabled me to make a more complete study of these organs in another species of the genus. A glance at a series of specimens of *Opsiphanes* will show that there are, on the hind-wings of the males, two brushes, one arising from the wing-membrane just below the middle of the submedian nervure, and the other from the lower edge of the cell, just opposite the origin of the first branch of the median. Plate I, fig. 1, is a diagram of the hind-wing of *Opsiphanes cassiae lucullus* ♂. *Sb* is the submedian brush, partly expanded, and *Mb* the median. If the abdomen of the insect be examined there will be found, laterally placed on the fourth and fifth segments, a bare patch, in the middle of which are two depressions, the larger in the fourth and the smaller in the fifth segment.

Each of these depressions is covered with a mass of special scales, and it will be observed that the submedian brush of the wing is capable of making contact with this abdominal organ when the wings are closed. The appearance of this abdominal patch is shown in fig. 2. Further examination shows that this organ is a secreting gland very similar to that of *Eryphanis polyxena*. We have, then, an abdominal gland as in *polyxena*, but differing in the fact that it acts in conjunction with a brush on the wing, which doubtless serves as a distributor of the volatile secretion, in the same way as, the positions being reversed, the abdominal brushes in the Danaine butterflies act as the distributors for the glands which, in those insects, are situated on the wings.

If we now examine the brush arising from the discoidal cell in *Opsiphanes*, its distal portion will be found to lie in a groove formed by a slight folding of the wing-membrance, close to the first branch of the median nervure, fig. 1, *g*. Lifting the brush with a needle, the groove or hollow in the wing-membrane is found to be lined with very dark, rather glistening scales. The distribution of these scales is variable. I have examined three examples of the insect suitably preserved. In one of them the dark scales formed a patch on the wing-membrane only, not extending to the nervure. In one of the others the special scales were also found on the nervure; whilst in the third, a small scaleless area intervened between those on the membrane and those on the nervure.

Fig. 3 is a much enlarged view of these organs as seen on the wing. *Mb* is the median brush with its distal end lying on the heavily scaled part of the wing. *Sb* is the submedian brush. Both are in their closed or resting condition. At *H* are some of the long hairs with which the space between the median and submedian is rather densely clothed. All the above features can be observed in ordinary dried examples in a cabinet. For the histological investigation of the organs, suitably preserved material is necessary, and for this I am greatly indebted to Senhor Roberto Spitz of São Paulo, Brazil, who, through Dr. Karl Jordan, very kindly sent the specimens carefully preserved and packed.

The glands on the sides of the abdomen are really duplicated, as in *Eryphanis polyxena*, the posterior being much the smaller, as shown in fig. 2. They consist of a dense layer of special secreting cells, each surmounted by a scale. A section of one of these gland-cells with part of its scale is shown in fig. 4. The cells bear a considerable resemblance to those found in *Eryphanis*. There is a large and conspicuous nucleus, *n*, often containing vacuoles.

The general cell-substance is finely granular, and where it surrounds the insertion of the scale assumes a faintly radiate striation as represented at *rs*. The scale-socket is rather complicated. The scale-stalk, *st*, is attached to a thick-walled chitinous tube, *cht*, further thickened and somewhat swollen at its inner end. From this tube there arises, above the middle of its length, a funnel-shaped structure, *ft*, the upper and outer edge of which joins the thick chitin, *ch*, of the external surface of the gland. This outer chitin not only forms a stout socket externally, but descends to form a still deeper internal socket, *is*. Round the chitinous extension of the scale-stalk is a second chitinous tube, *chtt*, the upper end of which is distended and the lower end nearly closed, leaving only a minute aperture through which, in some sections, granules, presumably of the secretion, may be seen passing. The scales attached to these sockets are rather irregularly shaped, striated, bag-like structures, several of which are shown together at fig. 11. Under a very high power there is apparently some indication of openings at the distal extremities, but probably the whole scale is permeable.

The apparatus thus closely resembles that of *Eryphanis*, but possesses in addition the submedian brush, which no doubt acts as a distributor of the secretion. The cells and scales are similar in both the large and small abdominal glands.

Fig. 5 is a transverse section of the wing, cutting through the glandular patch *gs, gs*, the median brush *bh*, and the first branch of the submedian nervure. At *ds* are seen some of the heavy dark scales which sometimes extend on to the nervule, but in this example are restricted to the surface of the wing. The space between the two wing-membranes and its extension into the nervule is lined with glandular cells, *gs*, from which arise two kinds of scales. In this section, those on the nervule, *n*, apparently resemble ordinary scales such as are found on other parts of the nervules, though, as already stated, special dark thick scales may sometimes be found extending right on to the nervule and replacing those of the ordinary form. Whether special or ordinary scales are present, we find beneath them actively secreting gland-cells, two of which are represented highly magnified at fig. 6. They differ from those of the abdominal glands in being shorter and more irregular in shape, and in having, round the scale-sockets, a vacuolated area, bordered by a radially striated cytoplasm more distinct and more sharply defined than in the abdominal cells. In the space just below the socket there is almost always found a small darkly-staining particle, *p*, which sometimes has a tubular, sometimes a granular appearance. It may be a trace of a minute duct normally extending into the cell from the centre of the scale-stalk. Between these gland-cells are smaller, undifferentiated cells, *ud*. Fig. 7 is a magnified view of one of the dark special scales, some of which are seen in section at *ds*, fig. 5. The hairs of both the median and submedian brushes have the same structure, being merely fluted cylinders with rather thick walls, as shown in section in fig. 9 and in side view in fig. 10.

If we make a longitudinal section of either of the brushes we see the structure shown in fig. 8. The hairs, *h, h*, arise from sockets of an ordinary type, but each hair has, at its base, between the wing-membranes, a large, heavily nucleated cell, *c*, the function of which is obscure. The appearance suggests activity, but the hairs show no signs of containing any secretion. It is conceivable that, since the hairs are used in life to take up and distribute the scent-material of the glands, they may be subject to some wear and tear, in which case the cells may be merely trichogenic, providing for continued growth. Similar cells are often found at the bases of insect hairs. On the other hand they may produce a volatile fluid which, when excreted, serves as a vehicle for the more viscous product of the gland-cells. Microscopic examination of perfectly fresh material might throw some light on this process, although such investigation could only be conducted where a supply of the living insect is available.

At fig. 8, *f, f*, are certain elongated nucleated structures, and these constitute the most interesting and unusual feature of the organs. Normally the brushes lie closed and flat on the surface of the wing in the positions shown in fig. 3. They are, however, capable of being erected, and the submedian brush is represented partially expanded in fig. 1. A series of dried specimens will usually show the brushes in both these conditions. Since the hairs are erectile there must be some mechanism controlling their movement. No trace of striated muscle can be seen in sections such as that shown in fig. 8. Other than the elongated cells described there is no structure which could conceivably control the expansion and contraction of the brushes. In view of their position the contraction of these cells would, by drawing together the upper and lower

wing-membranes, cause an erection of the brush. There would seem to be two possible explanations of their action. Either they are themselves contractile under a nervous stimulus, or they are merely elastic, and normally stretched by the blood pressure in the intermembranal space, but, when that pressure is removed or decreased, contract by their own elasticity, and so cause the approximation of the wing-membranes, and the consequent erection of the brush.

Unfortunately none of my material bears a brush in the expanded condition. Sections of such material would at least show whether, in that state, the cells are shorter and thicker, although even then the muscular, or alternatively the elastic nature of the fibres would not necessarily be disclosed. If this part of the wing be cleared and stained, the preparation thus made, when pressed flat on a slide, shows more or less fibre-like tissues radiating from the bases of the brush-hairs. Whether muscular or elastic, the mechanism seems to be of an unusual character, and not, so far as I am aware, found in other organs of this kind.

We have, then, a male butterfly with two separate and independent scent-organs, the different products of which may be simultaneously diffused and produce an effect only obtainable by the "nascent" action of the chemical substances involved. On the other hand, one gland may be repugnatorial and the other sexual. This, however, seems unlikely, since neither structure is to be found in the female. In the genus *Heliconius* both sexes have repugnatorial glands, although in different positions (*Trans. Ent. Soc.*, 1925, p. 269), but in that genus the male has special scent-scales on the wings quite independent of the gland, and presumably homologous with the scent-scales of Pierine and other butterflies.

Explanation of Plate I.

Scent organs of the male *Opsiphanes cassiae lucullus.*

Fig. 1. Hind-wing. *Mb*, median brush. *g*, glandular area of wing. *Sb*, submedian brush, partially expanded.
2. Lateral view of abdomen showing position of abdominal glands.
3. Magnified view of part of hind-wing. *Mb*, median brush. *Sb*, submedian brush. *H*, portions of the long hairs found on this area of the wing.
4. Highly magnified section of one of the abdominal gland-cells, with socket and part of one of the scent-scales. *st*, scale-stalk. *ch*, chitin of external surface. *ft*, funnel tube. *is*, internal socket. *cht*, chitinous tube. *chtt*, secondary chitinous tube. *rs*, radially striated area of cell. *n*, nucleus.
5. Section of nervule 2 of hind-wing. *n*, nervule. *gs*, *gs*, gland-cells. *ds*, dark thick scent-scales. *bh*, hairs of brush.
6. Two of the gland-cells from hind-wing. *p*, darkly staining particle, probably part of a duct. *ud*, undifferentiated cell.
7. One of the dark thick scent-scales.
8. Section through base of submedian brush. *h*, *h*, bases of brush-hairs. *c*, cell attached to base of a brush-hair. *f*, contractile (?) fibres.
9. Transverse section of a brush-hair.
10. Surface view of a brush-hair.
11. Several scales of the abdominal gland.

Length of gland-cell, fig. 4, ·1 mm. Length of scale, fig. 7, ·26 mm. Length of median brush, fig. 3, 5 mm. Diameter brush-hair, fig. 9, ·01 mm.

H. Ellringham, del. *Vaus & Crampton, Ltd.*

SCENT ORGANS IN *OPSIPHANES CASSIÆ LUCULLUS*, FRUHST.

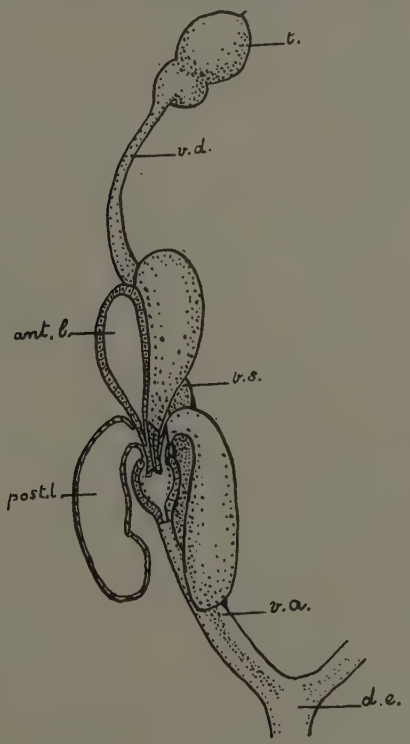
ON THE OCCURRENCE OF OXYHAEMOGLOBIN IN *MACROCORIXA GEOFFROYI*, LEACH

By Maud D. Haviland Brindley.

[Read December 5th, 1928.]

With One Text-figure.

In 1922, when in British Guiana, I collected a small Notonectid whose body contained a considerable quantity of red matter, which, from such tests as I was able to apply at the time, appeared to be oxyhaemoglobin. The coloured



Text-fig. 1.—*Macrocorixa geoffroyi*, Leach. Male genital organs of the left side, seen from above, semi-diagrammatic. × 50. *t* = testis. *v.d.* = vas deferens. *v.s.* = vesicular portion of vas deferens passing behind accessory glands. *v.a.* = vas deferens and duct of accessory glands. *d.e.* = ejaculatory duct. *ant.l.* = anterior lobe of accessory gland, containing haemoglobin. *post.l.* = posterior lobe of the same. (The left hand lobes of the accessory gland and the ampulla are represented in section.)

matter was contained in large round cells disposed in a mass in the ventral body cavity, and intimately connected with the tracheal system. On my return to

England, I found that Professor H. B. Hungerford of Kansas University had recently described an identical structure containing oxyhaemoglobin in a North American Notonectid of the genus *Buenoa* (*Canadian Entomologist*, Nov. 1922). Haemoglobin is of rare occurrence in insects, and only two or three other instances are known; but as it seemed possible that it might exist in some English water-bugs, I examined from time to time such forms as were available with this end in view. In January 1928 I found a red substance present in the male of the large water-boatman, *Macrocorixa geoffroyi*, Leach, and Professor Barcroft, who was good enough to examine it for me, pronounces it to be oxyhaemoglobin, but unfortunately it is present in such small quantities that hitherto further analysis has not been possible.

The haemoglobin is found only in the accessory gland of the male genital system. This organ actually consists of two pairs of elongated glands, arranged one in front of the other. The anterior pair, of which the outer is slightly the smaller, contain the haemoglobin. They are sausage-shaped bodies, and in dissection their bright red colour renders them conspicuous in the general anatomy. The posterior pair of glands, though similar in form, are rather larger and are pale and transparent in appearance. Both pairs of glands consist of a single-layered wall of cells enclosing a large lumen. This lumen, in the case of the anterior pair of glands, is filled with oxyhaemoglobin in solution. The surrounding cells are large and quadrilateral, with well-defined nuclei and walls. The cells of the posterior glands are less well differentiated and more flattened. They show signs of degeneration, and the colourless plasma which fills the lumen does not take up stain. Both pairs of glands are much attenuated towards their proximal ends and open separately into a common ampulla. The orifices of the two haemoglobin glands are inmost: those of the two colourless glands lie outside them. The ampulla leads to a common duct which is provided throughout its length with a muscular coat. In *Corixa*, the vas deferens functions as a seminal vesicle, and in the adult male it appears with its walls thickened, and distended with spermatozoa. It passes below the accessory glands to their junction in the ampulla, and from this point the duct of the glands and the vas deferens are so closely applied together that only careful dissection can separate them. They remain perfectly distinct, however, throughout their course, and open into the ejaculatory duct side by side.

The function of the oxyhaemoglobin in the accessory gland is unknown. Haemoglobin is not found in the female of *M. geoffroyi*, nor so far in either sex of several smaller species of *Corixa* which have been examined. In these species the accessory glands of the males are of the same general form as that of *M. geoffroyi*, but the anterior pair are proportionately nearly twice as long, and are colourless and transparent like the glands of the posterior pair.

ON THE REPUGNATORIAL GLANDS OF *CORIXA*

By Maud D. Haviland Brindley.

[Read December 5th, 1928.]

With Five Text-figures.

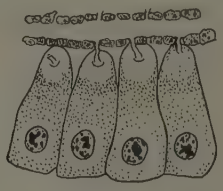
1. The Adult Gland.

It has long been known that many of the Heteroptera possess repugnatorial or stink-glands, and that these are dorsal and abdominal in the nymph and ventral and thoracic in the adult. The stink-apparatus was first studied in the bed-bug by Landois (*Zeitschr. wiss. Zool.*, vol. 18, 1868), and then by Kunckel (*C.R. Acad. Sci.*, t. ciii, 1886). In 1874 Mayer (*Archiv f. Anat. u. Phys.*, vol. 7) investigated the system in *Pyrrhocoris apterus*; and in 1884 Locy (*Amer. Nat.*, vol. 18) and in 1905 Bordas (*C.R. Acad. Sci.*, t. 140) described those of *Belostoma* and *Gerris* respectively. Kruger (1909, *Zeitschr. naturwiss. Leipzig*, vol. lxxxi) examined several water-bugs, including *Corixa*, but his notes are brief and incomplete; and Hagemann, who wrote a memoir on this form in 1910 (*Zool. Jahrb.*, vol. xxx), does not mention the stink-organs in detail. The most complete description of the odoriferous glands of the adult bug is that of *Cimex lectularius* by Puri in 1924 (*Parasitology*, vol. xvi). A comparison of this form with *Corixa* shows that the thoracic apparatus of both is on the same plan, and that they possess one feature in common which has not so far been recorded in other Heteroptera.

The species used in the following study were *Macrocorixa geoffroyi*, Leach, *Corixa fossorum*, Leach, and *C. striata*, Linn. The first was preferable owing to its larger size, but it was not always obtainable.

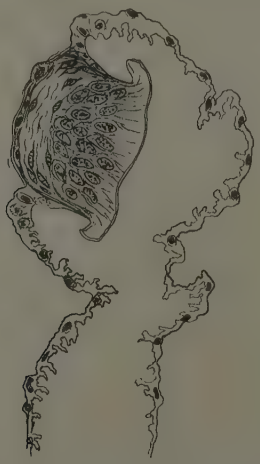
The stink-apparatus of the adult *Corixa* consists of a pair of secreting glands and a reservoir. The latter is provided with an accessory gland and efferent ducts. The organs lie immediately posterior to the thoracic ganglion. The median nerve to the ventral body wall passes above and to the left side of them, and the oesophagus lies above them on the right. Laterally they are bounded by the flattened triangular apodemes of the metasternum. The whole apparatus is so enclosed by the surrounding endosternum and the great muscles of the swimming legs that dissection is not easy. The glands are a pair of cylindrical curved tubes, with the distal ends coiled dorsally. Each tube consists of a single layer of large secreting cells surrounding a central collecting duct, which is lined with very small epithelial cells. At the outer and wider end of each secreting cell is a large nucleus with well-marked nucleolus. The inner and narrower end which abuts on the collecting duct contains a zone of lightly staining cytoplasm, within which, arising from a secretory vesicle, is a ductule which leads into the collecting duct (Text-fig. 1). The glands open separately into the neck of the reservoir just behind the meta-xiphus. The reservoir itself comes into view as soon as the body of the insect is opened, and owing to its orange colour is a conspicuous object in the anatomy. It is oval in form, somewhat flattened from side to side, and the duct enters near the anterior end. The walls of both reservoir and duct are thick, wrinkled, and formed by a thin layer of chitin which is lined externally by a flattened

pigment-laden epithelium, with small nuclei and indefinite cell walls. When viewed externally there is a white spot abundantly supplied with tracheae on the right side of the reservoir. In section this is shown to be a thickened cushion of glandular cells, with the convex surface expanded and projecting



TEXT-FIG. 1.—Secreting cells with intracellular ductules, and collecting duct of stink-gland of *Corixa*. × 500.

into the lumen. The cells of this accessory gland are elongated, with the inner ends much attenuated, and the large oval nuclei lie at the outer ends which are directed towards the general body cavity (Text-fig. 2). The chitinous coat of the reservoir is carried inwards over the cell mass, and the cells open separately into the lumen through pores in the chitin.

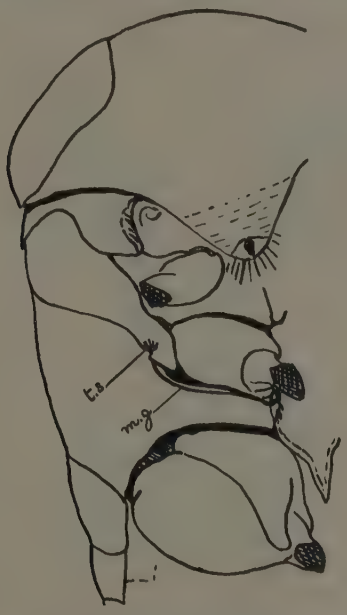


TEXT-FIG. 2.—Section through the reservoir and accessory gland of *M. geoffroyi*, seen from the front. × 175.

The wide duct of the reservoir leads downwards vertically to the floor of the metathorax where it opens into a narrow cavity, which, flattened dorso-ventrally and truncate behind, extends laterally to the anterior angles of the endosternite. Here it communicates on either side through a pore with a groove which extends along the anterior margin of the metacoxa.* This

* I am indebted to Professor H. B. Hungerford for calling my attention to this groove. It appears to be formed by the anterior margin of the metathoracic episternum, and by the lamella of the latero-sternite of the metasternum.

groove terminates in a brush of minute setae (Text-fig. 3). There appear to be no muscle fibres in either the reservoir or its duct, and when empty the walls come together by their own elasticity. The secretion is a yellowish fluid which floats in water in oily droplets. The reservoir is very retentive of its secretion, and the apparatus may be cut out of the animal without the escape of the fluid. A sphincter muscle, however, cannot be demonstrated; and the means by which the secretion is forced out along the metacoxal grooves is obscure. Indeed Reuter (*Acta Soc. Sci. Fennicae*, 1909) denies that the thoracic glands of the Hydrocorisae possess an external opening; but the adult *Corixa* when handled emits a raw bug-like odour, though in my experience

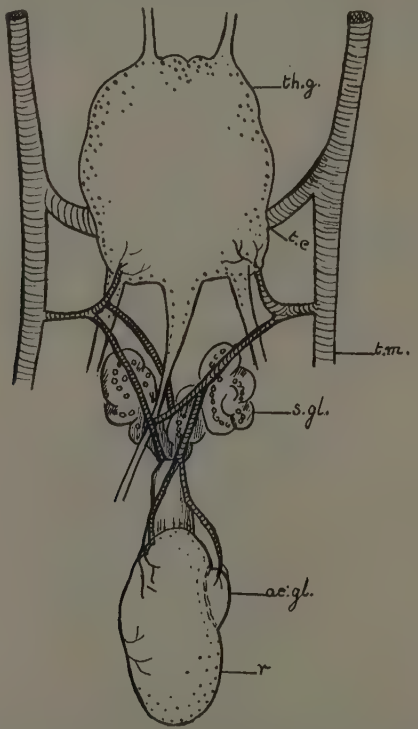


TEXT-FIG. 3.—Ventral view of *Corixa* to show metacoxal groove (*m.g.*) and terminal tuft of setae. (*t.s.*)

it reacts less readily than the nymph in this particular, and the coxal grooves are undoubtedly homologous with the odoriferous orifices of other Heteroptera.

The stink-apparatus of *Corixa* is partly asymmetrical since the accessory gland is found upon one side only; and this is borne out by the tracheal supply to the organs. On either side of the body, arising from the large tracheal trunk which supplies the metathoracic leg, is a trachea which divides and sends one stem forward to the thoracic ganglion and another backwards to the stink-apparatus. The glands are aerated virtually entirely from the left-hand stem, which sends a strong branch down towards the endosternite. The twigs to the reservoir from this source are comparatively feeble and serve only a small portion of the posterior surface. The branch from the right-hand stem supplies the rest of the reservoir, including the accessory gland; and it is moreover connected by a commissure with the reservoir branch of the left-hand side

(Text-fig. 4). To put it briefly, the glands are aerated by the left tracheal system, and the reservoir by the right. At first sight it seemed possible that the asymmetry of the stink-apparatus was correlated with that of the male abdomen; but that this is not the case is shown by *Macrocorixa geoffroyi* in which the asymmetry of the abdomen is sinistral, but that of the stink-organs, as in all the smaller CORIXIDAE examined, is dextral, with the accessory gland placed on the right of the reservoir.

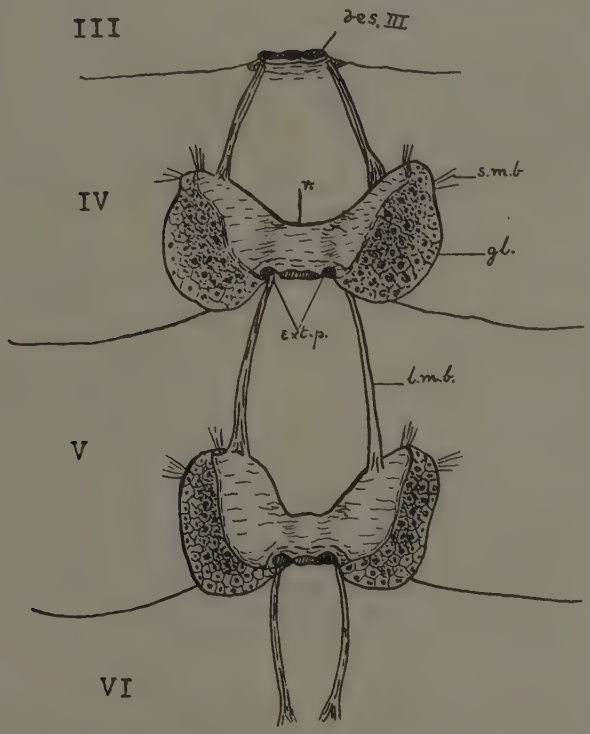


TEXT-FIG. 4.—Schematic view of stink apparatus of *Corixa* as seen from above to show tracheal supply. *ac.gl.* = accessory gland of reservoir. *r.* = reservoir. *s.gl.* = stink-glands. *t.c.* = commissure of main tracheal trunks. *th.g.* = thoracic ganglion. *t.m.* = tracheal branch to metathoracic leg.

The adult stink-organs are visible in the second and third instars as two hypodermal buds in the metathoracic region. These buds grow in length along the antero-posterior axis. From the anterior portions, in the succeeding instar, the glands are differentiated. The posterior portions, which grow together and coalesce in the middle line, give rise to the reservoir and duct of the adult. The accessory gland appears in the fourth (or possibly in the third) instar as a thickening of the reservoir wall. At one point it is possible to recognise a corresponding thickening on the wall of the opposite side, at a slightly lower level, but this soon disappears. At this stage the developing duct is somewhat flexed towards the left.

2. The Nymphal Glands.

The nymphal stink-glands of Heteroptera, which are situated on the dorsum of the abdomen, have attracted less attention than the thoracic glands of the adult; and their histology has been described only by Mayer for *Pyrrhocoris apterus* and by Puri for *Cimex* in the papers already cited. In both these forms the secreting cells are stated to surround a central lumen which functions as a reservoir.



Text-fig. 5.—Diagram of nymphal glands of *Corixa*, as seen in optical section from above. III–VI = tergites of the 3rd–6th segments. *ext.p.* = external pores. *gl.* = gland. *r.* = reservoir. *l.m.b.* = longitudinal muscle bands. *s.m.b.* = short muscle bands to the body wall. *ves.* III = vestigial gland of III.

In the Corixidae there are three glands, opening on the margins of the third, fourth, and fifth segments, but the gland of the third segment is vestigial. The two remaining glands consist of a central reservoir opening to the exterior by two orifices connected by a transverse suture, and by two lateral kidney-shaped masses of secretory tissue (Text-fig. 5). The latter are composed of two kinds of cells surrounding a central cavity which communicates directly with the reservoir at the anterior angles of the latter. The nymphal stink-apparatus is much flattened dorsoventrally, and lies closely pressed to the hypoderm above and to the dorsal vessel below. The gland proper consists of

a restricted number of large and somewhat flattened cells with conspicuous nuclei which are arranged principally round the periphery of the organ, and a mass of rounder, smaller interstitial cells which are disposed between the larger cells. The reservoir, which possesses a wrinkled chitinous lining, has a wall composed of cells with round nuclei and heavily charged with orange pigment granules. In *Corixa*, the specialised form of gland-cell described by Mayer in *Pyrrhocoris* appears to be absent, neither do the secreting cells surround the reservoir as described by Puri for *Cimex*.

Unlike the thoracic reservoir of the adult, the nymphal reservoir has a muscular coat by whose contraction the organ may be suddenly and completely emptied. Besides this the reservoir is attached by diagonal muscle bundles to the dorsal hypoderm, and there are in addition three pairs of muscular bands connecting each reservoir with the anterior rim of the orifice of the apparatus of the segment in front of it. The posterior pair, which are slighter than those of the other two segments, arise from the orifice on tergite V and pass back to the intersegmental membrane of tergite VI. It is possible to observe the contraction of the reservoir of a nymph of *M. geoffroyi* if the insect is anaesthetised and then the tergites are separated from the body-wall and lifted up. If the reservoir has not already been discharged at capture, it will appear distended with secretion, and if touched with a bristle the walls will collapse spasmodically, ejecting a white turgid fluid through the orifices. This fluid, which mixes slowly with the surrounding water, is indistinguishable in odour from that of the adult gland though unlike it in appearance.

There is some variation in the position and number of the nymphal glands of Heteroptera, and it is probable that an ancestral form possessed a full complement of these segmental abdominal glands. The number for a given species remains constant throughout nymphal life, and there is no progressive reduction as development advances. Vestigial glands are common, as in *Corixa*; and frequently there is a darkened area of chitin similar to, though smaller than, that found round the orifice of a functional gland in an adjoining segment. The variety in the distribution of the nymphal glands is illustrated by the accompanying table. Absence of all the glands is frequent, especially in highly modified forms such as Ploiariinae, Hydrometridae, Nepidae, etc., but this is not necessarily the case in the adult. In *Notonecta*, for instance, stink-glands are present in the adult but not in the nymph.*

3. Comparison between the Adult Gland of *Corixa* and that of other forms.

The adult stink-apparatus of Heteroptera appears to follow the same plan in the different families examined, and when present differs only in complexity. In *Corixa*, *Naucoris*, and *Notonecta* the glands are simple cylindrical tubes. In certain Capsidae (*Calocoris*, *Megaloceraea*) they are lobate with secondary ducts entering the common collecting duct; and this seems to be the case with *Gerris*, according to Bordas, and with *Cimex*. The reservoir of the latter, as described by Puri, consists of a median and two lateral chambers. The material at my disposal was not in a good state of preservation, but the arrangement in the Pentatomid *Mormidea ypsilon*, L., seems to be similar. In such Capsidae as I have examined, the reservoir is single-chambered, somewhat oblong as seen from above, and with the anterior angles drawn out to the external orifices. In *Notonecta glauca* it is small, fibrous, and non-pigmented; and in *Naucoris*

* Though well-marked glands are present in *Notonecta*, I can detect no odour in this form.

cimicoides it is flaccid and transparent. Thus in *Corixa* it appears that the reservoir has been so constricted that the lower two-thirds of the organ are reduced to the proportions of a simple duct above the metacoxal grooves. The accessory gland of *Corixa* is evidently homologous with the "kidney-shaped organ" described by Puri in *Cimex*. The function of this structure is obscure. In *Corixa* its abundant tracheal supply testifies to its activity; but its absence in other bugs which have a pronounced odour, such as *Rhopalotomus ater*, shows that it is not an essential part of a stink-apparatus. Sections cut through the reservoir of *Rhopalotomus* and allied forms demonstrate that there is no thickening of the reservoir wall at any point; but the epithelial cells which compose it are much less flattened than the corresponding cells in *Corixa*, and their nuclei are proportionately larger.

As to the function of the stink-apparatus in the adult *Corixa*, there is no need to look beyond defence. The insect frequently leaves the water, and it is then exposed to all the dangers met with by the land Heteroptera. Also there is no reason to doubt that the odoriferous secretion is equally efficacious against enemies in water.

TABLE TO INDICATE THE NUMBER AND POSITION OF THE STINK-GLANDS IN THE NYMPHS OF CERTAIN HETEROPTERA.

		III.	IV.	V.	VI.
Pentatomidae.	*Cyrtocoris gibbus*	−	+	+	−
	Brachystethus cribrum	*v*	+	+	*v*
	Mormidea ypsilon	*v*	+	+	−
	Acanthosoma haemorrhoidale	*v*	+	+	*v*
Phymatidae.	*Phymata erosa*	+	+	−	−
Reduviidae.	*Apiomerus hirtipes*	+	+	+	−
	Zelus sp.	+	+	+	*v*
	Ghilianella	−	−	−	−
Lygaeidae.	*Lygus* sp.	−	+	+	−
Coreidae.	*Spathophora clavata*	−	+	+	−
	Hyalmenus pulcher	−	+	+	−
Capsidae.	*Miris laevigatus*	−	+	+	−
	Rhopalotomus ater	−	+	−	−
Pyrrhocoridae.	*Pyrrhocoris apterus*	+	+	+	−
Cimicidae.	*Cimex lectularius*	+	+	+	−
Saldidae.	*Salda littoralis*	−	+	−	−
Corixidae.	*Corixa*	*v*	+	+	−

The roman numerals refer to the abdominal segments: *v* = vestigial gland.

COLLEMBOLA FROM ABYSSINIA

By Dr. Eduard Handschin.
(a.o. Professor of Zoology, University of Basle.)

[Read December 5th, 1928.]

With Eight Text-figures.

The Collembola of Eastern Africa are scarcely known. There are only six papers published during the last twenty-five years dealing with records from this part of the "dark continent." Wahlgren in 1903 * described seventeen species obtained by the Swedish Zoological Expedition to the White Nile. In 1907 Börner † studied the material brought back by Voeltzkow's Expedition. In 1908 Wahlgren ‡ gave some information about the forms living at the highest elevations in Africa, the Kilimandjaro and Meru. Nearly ten years afterwards Silvestri § mentioned some termitophilous species from Eritrea, then Denis ‖ in 1924–25, by working up the Collembola of the Paris Museum, added a contribution on some forms collected in Abyssinia, and in 1926 Philiptschenko published the latest record on the Collembola of British East Africa.¶ With Denis' paper this is the most important account of these Arthropods of the region under review, showing exceedingly close affinities between the fauna of the Central and of the East African mountain regions. Unfortunately, Philiptschenko's paper (written in 1917) was only published in 1926, so that several names have to be dropped in favour of those used by Denis in 1924–25.

To these records the present paper may be added. In contains the results of determination of a collection of Collembola which was made by Dr. Hugh Scott and Mr. J. Omer Cooper in Central Abyssinia in 1926.

The localities in which the material was collected are: Addis Ababa, *ca.* 8000 feet; Jem-Jem Forest, 8000–9000 feet (about 45 miles nearly due West of Addis Ababa); Wouramboulchi, a short distance West of Jem-Jem, *ca.* 9000 feet; Mt. Chillalo, 9000–13,000 feet; and Mt. Zukwala, 9000 feet.

Whereas the material recorded is small, it nevertheless gives a good idea of the composition of the Collembolan fauna of the whole country and allows to be traced the affinity of the fauna with that of the surrounding regions. In all, twelve species could be recognised, as follows :—

1. *Pseudachorutes mirabilis*, n. sp.
2. „ *handschini*, Den. 1924.
3. *Achorutes montanus*, n. sp.
4. *Lepidocyrtus cyaneus*, Tullb. 1917.

* Walhgren, E., 1903: Apterygoten aus Aegypten, dem Sudan, in *Results of the Swed. Zool. Exped. to Egypt and the White Nile*, 1901, No. 15, pp. 1–72.

† Börner, C., 1907: Collembolen aus Ostafrika, Madagaskar, Süd-Amerika, in *Voeltzkow, Reise in Ostafrika*, 1903–1905, Vol. 2, pp. 147–178.

‡ Wahlgren, E., 1908: Apterygogenea, I. Collembola, in *Wiss. Erg. schwed. Zool. Exped. Kilimandjaro-Meru*, 1906, No. 18, pp. 1–10.

§ Silvestri, F., 1917: Contribuzione alla Conoscenza dei Termitidi e Termitofili dell' Africa occidentale. II. Termitofili. Parte prima, *Boll. Lab. Zool. Portici*, Vol. XII, p. 312.

‖ Denis, I. R., 1924, 1925: Sur les Collemboles du Museum de Paris. *Ann. Soc. ent. France*, Vol. 93, pp. 211–260; Vol. 94, pp. 261–290.

¶ Philiptschenko, Jur., 1926: On the Collembola collected by the Expedition of V. A. Dogiel and I. I. Sokolow in British East Africa; *Rev. Russe. Ent.*, XX, pp. 180–196.

5. *Lepidocyrtinus subdomesticus*, Den. 1924.
6. ,, *annulipes*, n. sp.
7. ,, *cooperi*, n. sp.
8. *Paronella nigromaculata*, Schött 1903.
9. *Dicranocentrus stachi*, (Den.) E.H.
10. ,, *aethiopicus*, n. sp.
11. *Cyphoderus arcuatus*, Wahlgr. *aethiopicus*, n. var.
12. *Ptenothrix violacea*, n. sp.

With the exception of the cosmopolitan *Lepidocyrtus cyaneus* all these forms are endemic to the country. Three were recorded by Denis in 1925, and seven are new to science.

1. **Pseudachorutes mirabilis**, n. sp.

Figs. 1–6.

Diagnosis :—Length 2–3 mm. Coloration dark velvety blue with orange patches. The terminal segments of the antennae, frons and middle of head between the eyes, the two lateral tubercles on Th. II and III and the sides of Abd. III are orange. Ventral side and appendages bluish-white, coxae and trunk of the mouth-parts dotted with blue. The general form of the body is broad, coarse and resembles that of *Ceratrimeria*. Abd. IV two-lobed, on each side drawn over the small Abd. V. Abd. VI placed entirely on the ventral side of the animal. Antennae four-segmented, limit between Ant. III and IV scarcely to be recognised from above. Antennal organ III consisting of two short, straight sensory bristles with protecting hairs. It is free, no groove could be observed. Ant. IV with trilobed apical papillae. Skin papillated, each small papilla with secondary granulations. Hairs scarce, bristles short, simple. Ommatidia 6 on each side. Postantennal organ nearly twice as large as one ommatidium, consisting of about 80 small tubercles, grouped closely together. Trunk long, with sucking mouth-parts. Mandibles with a fine toothed edge apically. Maxillae pin-like, without appendages. Claw with inner tooth. Lower claw absent. No tenant hair present. Furca small, the mucro-dens equals the length of the claw. Dentes with five bristles. Mucro boat-like, similar to that of *Ceratrimeria*. Retinaculum with two teeth in the rami. Dentes only twice the length of mucrones. Anal and genital orifice situated on the ventral side.

As stated above, the species resembles *Ceratrimeria* from the Papuan region. In both cases is manifested a tendency to the formation of abundant secondary tubercles in the postantennal organ.

Loc. Edge of Serpent Lake, Wouramboulchi, *ca.* 9000 feet, 2.x.1926, 2 examples; Jem-Jem Forest, 8000–9000 feet, 24.ix.1926.

Pseudachorutes mirabilis is closely allied to *Ps. flavoantennatus*, Philipt., from Mabira forest in East Africa. Possibly both should be regarded as varieties of the same species. Nevertheless, the differences allow *mirabilis* and *flavoantennatus* to be separated as distinct forms.

	mirabilis.	*flavoantennatus.*
Length	2–3 mm.	1·75–2 mm.
Colour	Dark blue, with large frontal lateral spots on Th. II, III and Abd. IV.	Dark blue with small orange dots on the dorsal side and Ant. III and IV orange.
Postantennal organ,	*ca.* 80 tubercles.	*ca.* 30 tubercles.
Ommatidia . . .	6 + 6	8 + 8
Mucro : Dens. . .	= 1 : 2.	= 1 : 1.

Unfortunately from the drawings given in PHILIPTSCHENKO's paper it is impossible to establish further relationships or differences between the two forms in question.

TEXT-FIG. 1.

Figs. 1–6.—*Pseudachorutes mirabilis*, n. sp.

1. Whole animal, ventral side.
2. Whole animal, dorsal view.
3. Antennal organ III.
4. Postantennal organ and two ommatidia.
5. Claw.
6. Spring.

2. **Pseudachorutes handschini,** Den. 1924

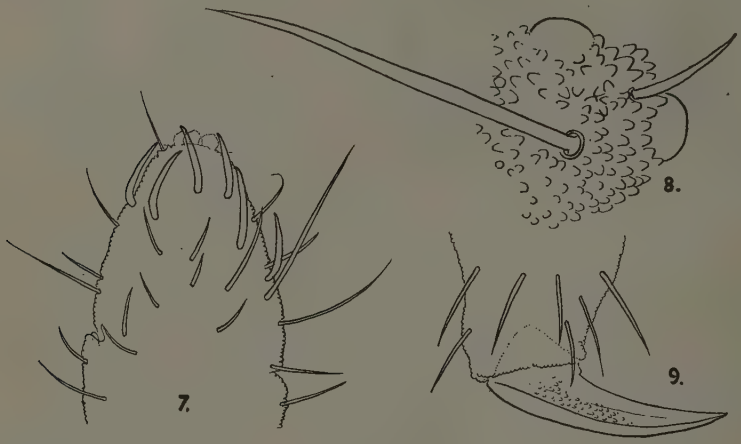
The material identified as *Pseudachorutes handschini*, Den., agrees in general shape, in the structure of the postantennal organs and in the eyes, with the diagnosis given by DENIS. The fine dentelation on the inner margin of the claw could not distinctly be seen. In the material before me it seems that there are two separate teeth, close together one above the other. Since this is the only difference between the two forms, a separation into two species is not desirable. Most probably PHILIPTSCHENKO's *P. mabirensis* is closely allied with the form described by DENIS. The most remarkable difference between them is shown

in the relative size of the postantennal organ and the pigmentation. In *handschini* the ommatidia are as large as the whole postantennal organ, whilst in *mabirensis* the postantennal organ is 2 to 3 times as large as a single cornea.

Loc. Summit of Mt. Chillalo, 12,000–13,000 feet, 21.xi.1926, from inside of decaying woody stem of giant Lobelia (*Rhynchopetalum montanum*), 1 specimen, Addis Ababa, *ca.* 8000 feet, ix.1926, 1 specimen.

3. **Achorutes montanus,** n. sp.

Diagnosis :—Length 2 mm. Colour of preserved specimens white. Ant. III and IV fused together; on the limit of the two segments, situated in a groove, is the characteristic antennal organ III. Ant. IV with 6 large, curved, sensory hairs, the apex with a three-



Text-fig. 2.

Figs. 7–9.—*Achorutes montanus,* n. sp.

7. Terminal segment of the antennae.
8. Ommatidia.
9. Claw.

lobed retractile terminal knob. The subapical groove bearing a long straight bristle. Ommatidia two on each side, colourless.

Skin with small tubercles, but not divided into different prominent areas as in other Oriental species. Bristles long, scarcely serrate, almost smooth. In addition to the long hairs of the body there are small areas of the skin, surrounded by tubercles, similar to those found in *Gnatholonche*. The claw is simple, without tooth.

Achorutes montanus resembles *A. sokolowi*, Philipt., in the presence of only two ommatidia. The sculpture of the skin and also of the tubercles does not show so clearly as in *sokolowi* ; this latter form is especially remarkable owing to the protruded, thorn-like lateral tubercles found on the last three abdominal segments.

Loc. Jem-Jem Forest, 8000–9000 feet, 22.ix.1926, 1 specimen.

4. **Lepidocyrtus cyaneus,** Tullb. 1871.

This example from Abyssinia resembles in all its parts the typical specimens recorded in Europe. The pigmentation extends over the whole body, but as the specimen here recorded is moulting, this feature is not seen in every part of it. The distal margins of the segments seem to be marked with rather brown transverse stripes, due to the presence of large, brown, rounded scales in this region.

Wahlgren described *Lepidocyrtus cyaneus* var. *assimilis* Rt., from Kilimandjaro and a nearly unpigmented variety (*pallida*, Rt.) from Egypt.

Loc. Jem-Jem Forest, *ca.* 8000 feet, 26.ix.1926, 1 specimen.

5. **Lepidocyrtinus subdomesticus,** Den. 1924.

Sira subdomestica, Den., 1924.

Length 2·5 mm. Bright yellow without dark pigment, except the eye-patches and frontal ocellus. Ommatidia 8 on each side. Hairs rather scarce, more abundant on the appendages than on the body; bristles plumate; Ant. III distally, IV entirely, annulated and densely covered with bristles. Long, thorn-like, smooth bristles are present, especially on the inner side of the legs. Scales oval, with fine hair-like structure; they cover not only the body but also the head, legs, furca and Ant. I–III. Tibia of hind leg secondarily divided. Claw with 3 inner teeth situated respectively $\frac{1}{2}$, $\frac{3}{4}$ and $\frac{7}{8}$ of the length from the base of the claw. Pseudonychia present. Tenant hair long. Mucro falciform.

Proportions. Head : Abd. III : Abd. IV = 115 : 10 : 43.

Loc. Mt. Chillalo, heath-land on summit, 12,000–13,000 feet, 18.xi.1926. 1 example; Jem-Jem Forest, 8000–9000 feet, 13.x.1926, 2 examples.

This species has been recorded by M. de Rothschild from Onotchocha and Kounhi and described by Denis under the name *Sira subdomestica*. The change of name has been recently discussed.*

6. **Lepidocyrtinus annulipes,** n. sp.

Diagnosis :—Body-length up to 4 mm. Coloration yellow with variable blue markings. Ant. III and IV always violet. Eye-patch and ocellus dark blue. A spot on coxae I, trochanters II and III distally and a ring at the end of femora II and III, of the same colour.

Hairy covering long and dense, especially on the appendages. On each body-segment are groups of long spatulate bristles, symmetrically arranged along the median line. On Th. III to Abd. III they are arranged in a line in the middle of the segment. Between these groups of hairs the rounded scales are of considerable size. They are brownish and have a fine striated structure and may be found also on the 3rd segment of the antennae and the other appendages. Ant. III and IV annulated. Ommatidia 8 on each side. Claw with two large basal teeth, situated close together, and two teeth on the distal part, the latter very small. Pseudonychia present, empodial appendage straight, toothless. Tenant hair very long, reaching to the apex of the claw. Mucro falciform.

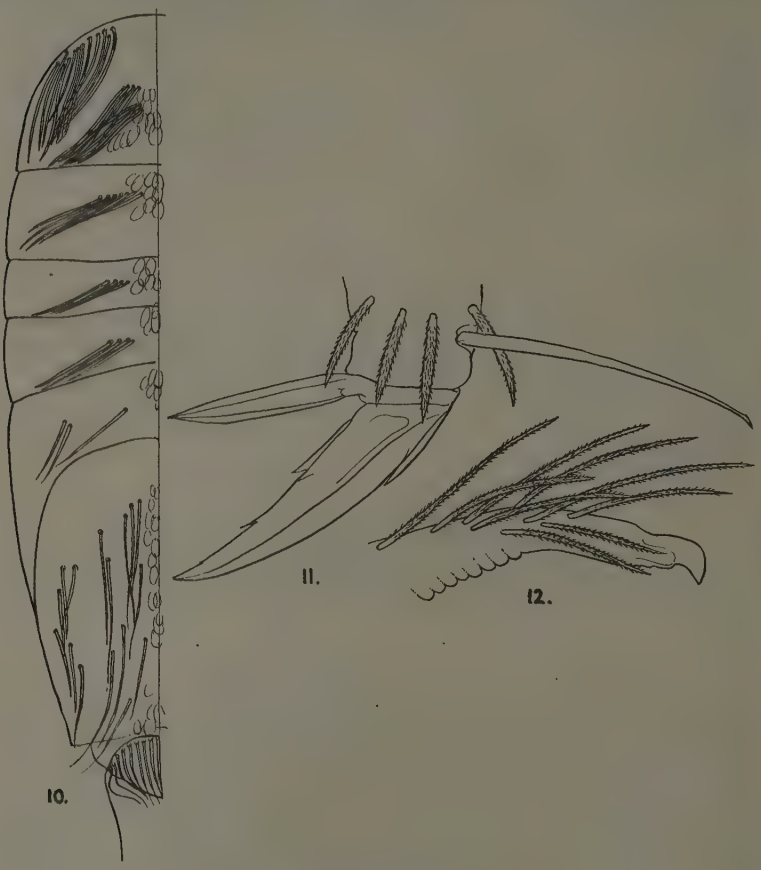
Proportions of Abd. III : Abd. IV = *ca.* 1 : 5.

The variation in pigmentation in different individuals is seen posteriorly on Ant. I to III, where it may be diffuse, or forming distinct annular rings at the

* Handschin, E. Beiträge zur Collembolenfauna der Sundainseln; *Treubia*, Vol. VI, 1925, p. 290.

Handschin, E. Materialien zur Revision der Collembolen : *Sira platani* Nic.; *Tät. Ber. Natf. Ges. Baselland*, 1926, p. 85.

distal end of the segments. On the coxae and subcoxae the patches extend in the same manner and the basal half of the femora becomes gradually blue. Rarely this colour appears on the body, where only the lateral borders of the



Text-fig. 3.

Figs. 10–12.—*Lepidocyrtinus annulipes*, n. sp.

10. Distribution of hairs on the dorsum.
11. Claw.
12. Mucro.

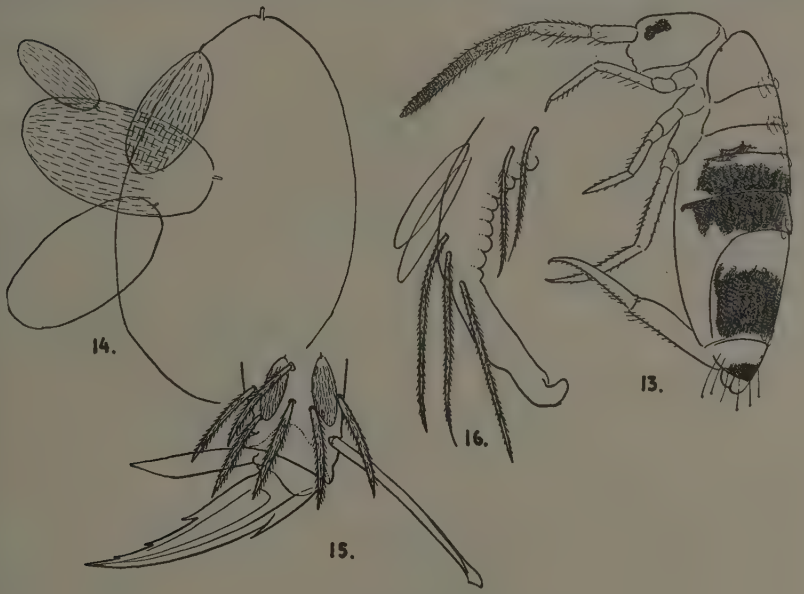
tergites may show traces of blue. In the darkest individuals of the collection the whole body is blue-violet, but the dorsum, with the exception of Abd. III, remains yellowish, although the appendages are entirely dark. As the dark colour extends progressively in the darker examples, the characteristic markings on the legs are apparent.

Loc. Addis Ababa, *ca.* 8000 feet, 16.ix.1926; Jem-Jem Forest, 8000–9000

feet, between 22.ix and 11.x.1926, 49 specimens; Mt. Chillalo, heath-land on summit, 12,000–13,000 feet, 18.xi.1926, 23 examples; from inside decaying woody stem of giant Lobelia (*Rhynchopetalum montanum*) on summit of Mt. Chillalo, 13,000 feet, 21.xi.1926, 2 examples; top of Mt. Zukwala, *ca.* 9000 feet, 24.x.1926, 18 examples.

7. **Lepidocyrtinus cooperi,** n. sp.

Diagnosis :—Length 3·5 mm. Colour yellowish; dorsum somewhat darker, eye-patch and frontal ocellus black. Dorsal part of Abd. II and III almost black, also distal $\frac{3}{5}$ of



Text-fig. 4.

Figs. 13–16.—*Lepidocyrtinus cooperi,* n. sp.

13. Whole animal, side view.
14. Scales.
15. Claw.
16. Mucro.

Abd. IV and posterior margin of Abd. V. On Abd. II a small lateral band on the posterior margin is of the same colour. Ant. III and IV violet, fourth segment annulate. Appendages densely covered with hairs. Long spatulate hairs are present as a " collarette " on the mesothorax and as an anal tuft. Scales large, brown, variable in size, always rounded and with fine structure; also present on the antennae, legs and spring.

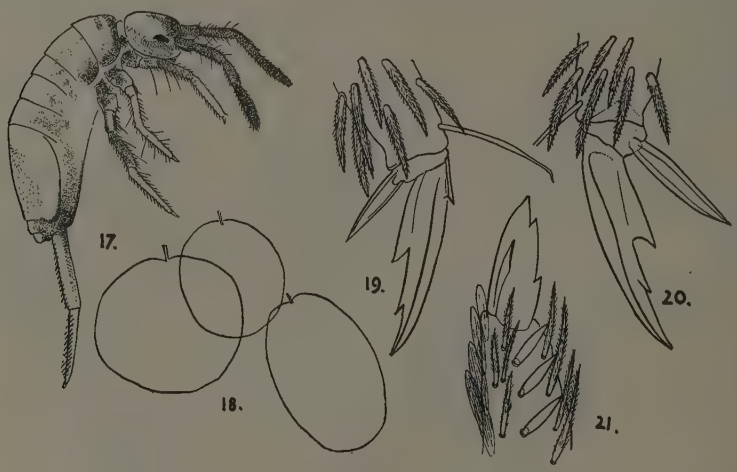
Claw with three inner teeth and pseudonychia. Empodial appendage lanceolate, tenant hair long and strong, as long as the claw; tibia III with secondary division. Mucro falciform, surrounded by long plumose bristles.

Loc. Addis Ababa, *ca.* 8000 feet, 16.ix.1926, 3 examples; Jem-Jem Forest, 8000–9000 feet, 22 and 26.ix.1926, 5 examples.

This form is closely allied to *L. pulchellus*, described by WAHLGREN from the White Nile, but differs from it by the absence of dark transverse bands on the posterior border of the head, of Th. III, Abd. III and VI. Besides this, *pulchellus* has only two inner teeth in the claw. *Lepidocyrtinus schäfferi*, Schött, a similar form from the Far East, has no pigmentation on Abd. IV.

8. **Paronella nigromaculata,** Schött 1903.

Diagnosis :—Length 2·5–3 mm. Colour brownish-yellow with diffuse violet pigment, which is especially dark on the antennae, the anterior part of the head, on the sides of the



TEXT-FIG. 5.

Figs. 17–21.—*Paronella nigromaculata*, Schött.

17. Whole animal, side view.
18. Scales.
19. Claw of first leg.
20. „ of second leg.
21. Mucro and dental spines.

thorax and on Abd. I–III, also on coxae and femora I and III. Eye-patches black, each with 8 ommatidia. Antennae relatively short, scarcely $\frac{2}{3}$ the length of the body. Hairy covering dense on the appendages and accentuated on the inner side of the legs by long setae. Scales large and round, also present on spring and Ant. I and II. Legs without scales.

Claw with large basal lamella-like tooth and a smaller one in the distal part. Pseudonychia present. Empodial appendage lanceolate, in the first leg reaching only to the lower, in the hind to the upper, tooth of the claw. Tenant hair rather small. Dentes with a row of large spines from the base to the mucro. The latter with 3 teeth on the middle edge and an outer one on the side.

Proportions. Head : body = 35 : 130. Abd. III : Abd. IV = 15 : 48. Manubrium : dens = 40 : 35(3). Tibia I : Tibia II : Tibia III = 23 : 23 : 34. Ant. I : Ant. II : Ant. III : Ant. IV = 13 : 17 : 14 : 24.

Loc. Jem-Jem Forest, 8000–9000 feet, 10.x.1926, 4 examples.

Paronella nigromaculata is related to *Paronella fülleborni*, Börner, from Lake Nyasa. According to Börner's description both show nearly the same coloration, but differences in the structure of the claws, which in the Central African species bear a second distal tooth on the inner side, as already described by Wahlgren and Philiptschenko. According to the latter, *fülleborni*, Börner, is a synonym of *nigromaculata*, Schött.

Twelve species of the genus have been described: *carpenteri*, Den., *berlandi*, Den., *hirtipes*, Handschin, from South-America; *fusca*, Schött, *nigromaculata*, Schött, *atrofasciata*, Schött, *penicillata*, Schött, from the Cameroons (*nigromaculata* is also known from Central Africa and Abyssinia); *flava*, Carp. and *coerulea*, Carp., from the Seychelles (under *Microparonella*); *annulicornis*, Oud., from the Malay Archipelago; *dahlii*, Schäff., and *picta*, Schäff., from the Papuan region.

In this list are included the two forms from the Seychelles for which Carpenter erected the genus *Microparonella*.* A review of the old genus *Paronella*, given by Handschin in 1925,† shows that all the forms of this genus may be separated into four natural groups. For one group, including the type species, *fusca*, Schött, and embracing the whole of the above-mentioned series of forms, the old generic name *Paronella* is preserved. The more recently described and larger species are placed under *Pseudoparonella*, *Aphysa* and *Microphysa*.

To facilitate determination, the following key to the genera will be useful :—

1. Mucro small, with 2 to 4 teeth, scales rounded, large. Dentes with a row of spines. General shape like that of large Lepidocyrtidae.
   2. Mucro with only two teeth, often reduced to a stump. *Pseudoparonella*, Handschin.
   2‡. Mucro with 3 to 4 teeth, always well developed . . . *Paronella*, Schött.
1‡. Mucro large, with 5 to 7 teeth, scales elongate, often bristle-like. Body large, antennae extending beyond its extremity.
   3‡. Ant. I and II without long, dense, erect hair-tufts.
      4. Th. III hump-like, protruded . . . . . *Campylothorax*, Schött.‡
      4‡. Th. III normal.
         5. Dentes with small blister-like appendage . *Microphysa*, Handschin.
         5‡. Dentes without this appendage . . . . *Aphysa*, Handschin.
   3‡. Ant. I and II with long, dense, erect hair-tufts; ventral teeth of mucro forming an edge . . . . . *Dicranocentroides*, Imms.§

9. **Dicranocentrus stachi**, Den. 1925.

Heteromurus (*Heteromuricus*) *stachi*, Denis 1925.

The individuals in the collection agree closely with the diagnosis of Denis in coloration, position of the ommatidia, structure of claws and form of the mucro. But as the diagnosis is based on one single and incomplete specimen, several details were not observed by this author, such as the characteristic mass of dental spines, placed in several indistinct rows at the base of the dentes.

* Carpenter, G. H. The Apterygota of the Seychelles, *Proc. R. Ir. Acad.*, Vol. 33, Sect. B, 1916, p. 43.

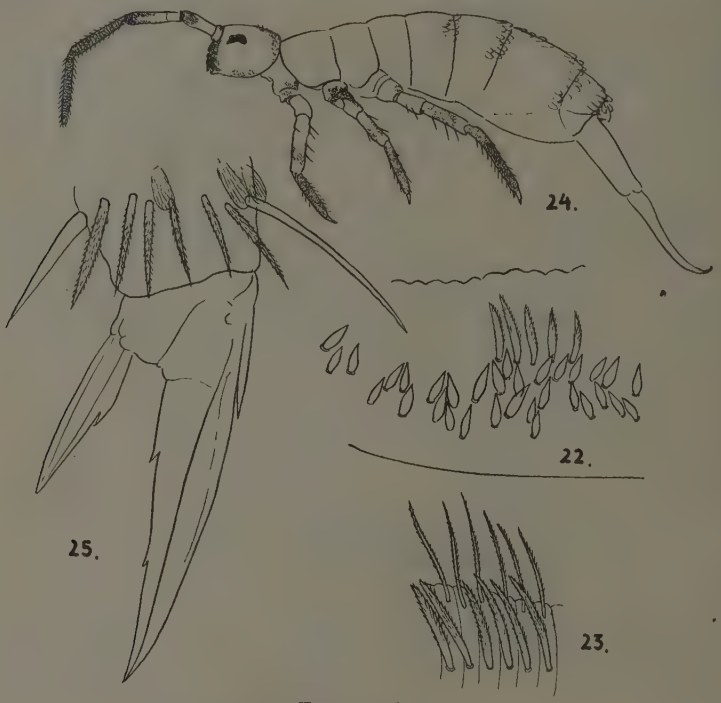
† Handschin, E. Beiträge zur Collembolenfauna der Sundainseln; *Treubia*, Vol. VI, 1925, p. 250.

‡ Schött, H. Beiträge zur Kenntnis der Insektenfauna von Kamerun; *Bih. till. K. Svensk. Vet. Akad. Handlung*, Vol. XIX, Afd. iv, no. 2, pp. 1–28, pl. i–vii, 1893.

§ Imms, A. D. On some Collembola from India, Burma and Ceylon; *Proc. Zool. Soc. London*, 1912, p. 102, figs. 45–47, 55, 68.

These spines are hardly to be seen, as they are covered by a series of long, plumose, thorn-like bristles. They are visible only when the spring is removed. The antennae are six-segmented, the last two segments being annulated.

As Denis remarks, the species resembles a *Heteromurus*. This is one of the general characteristics of *Dicranocentrus*, which genus may be regarded as inter-



Text-fig. 6.

Figs. 22–23.—*Dicranocentrus stachi*, Den.

22. Dental spines.
23. Distal dental bristles.

Figs. 24–25.—*Dicranocentrus aethiopicus*, n. sp.

24. Whole animal, side view.
25. Claw.

mediate between the genera *Heteromurus*, *Alloscopus* and *Heteromuricus*. Denis is in error in associating *Heteromuricus*, Imms, with *Heteromurus*, Templ., for *Heteromuricus longicornis*, Carp., from the Seychelles is certainly a *Dicranocentrus*. *Heteromuricus* has, as I convinced myself by examining about 40 specimens from India, a long abdominal appendage on the sixth abdominal segment, a character which has never been observed in other genera. *This appendage is free and articulated, and not a simple prolongation of the "valvulae supra-anales," and used in life as a sort of fan.* A detailed description

will be given in another paper. In no individual of *stachi*, Den., can the slightest trace of such an appendage be observed. Also it seems to me very dangerous to base such important morphological questions as these *on the presence of one single, damaged specimen*, as DENIS has done.

Loc. Mt. Chillalo, heath-land on summit, 12,000–13,000 feet, 18.xi.1926, 4 examples.

It remains to be stated that PHILIPTSCHENKO's *Heteromuricus dogieli* is also a true *Dicranocentrus*. As the details of the descriptions are not complete, it is impossible to trace the affinities with the following species.

10. **Dicranocentrus aethiopicus,** n. sp.

Diagnosis :—Length 3–4 mm. Colour brownish, body densely covered with large brown scales; mouth and head anteriorly dark blue; eye-patch black. Ant. II and III dark blue in the distal parts, V and VI entirely dark blue, also the tibia and diffuse spots on the subcoxae, coxae and femora. Antennae with a basal segment and a secondary division on Ant. II. The last two segments annulated. Ant. I–IV bearing scales. Ommatidia 8 on each side. Claw long, with strong basal and small subapical teeth on the inner margin. Pseudonychia present. Empodial appendage with tooth-like inner edge. Mucro rather long, with two teeth and basal spine, which is a characteristic of the whole group. Dentes at the proximal end with numerous rows of short spines (about 150), which extend in two series nearly to the mucro. Hairy covering on the appendages especially pronounced. The inner side of the dentes armed with long thorn-like bristles, as described in *D. stachi*. In several individuals traces of a " collarette " and an " anal tuft " are present. In small specimens the blue coloration is not so distinctly marked as in larger ones, whereas the teeth of the claw are much more distinct.

Loc. Jem-Jem Forest, 8000–9000 feet, between 21.ix. and 10.x.1926, 27 examples; Mt. Chillalo, *ca.* 9000 feet, from dead leaves and humus in forest, 14.xi.1926, 1 example; from a river South of Mt. Zukwala, *ca.* 6000 feet, 31.x.1926, 1 example.

This form is closely allied to *Dicranocentrus meruensis*, Wahlgr., a species from the forests round the Meru. It differs therefrom by the presence of a large inner tooth on the empodial appendage and, according to WAHLGREN'S description, in the form of the rows of dental spines. The presence of an inner tooth on the lower claw is combined with that of an outer one in *D. gracilis*, Abs., so that the new Ethiopian species may be regarded as a connecting link between *D. meruensis* and *D. gracilis*.

11. **Cyphoderus arcuatus,** Wahlgr., var. **aethiopicus,** n. var.

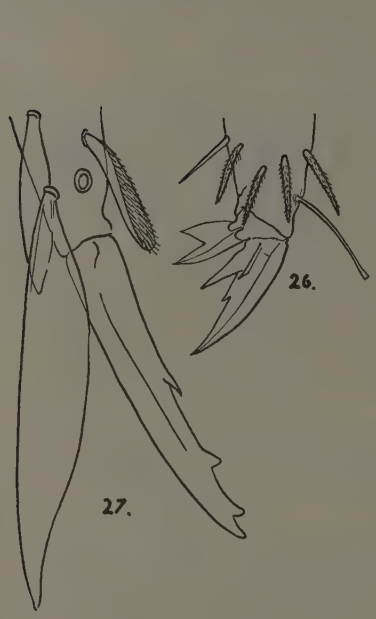
Diagnosis :—Length 1·5–2 mm. Entirely white, densely covered with scales and hairs, the latter especially on the appendages. Claw with one inner tooth and two large, basal teeth of unequal length. Empodial appendage with large lamella-like external tooth. Tibio-tarsus with feebly knobbed tenant hair. Dentes with large scales, the last somewhat longer than the mucro. Mucro with a forwardly directed spine, situated about its middle, and three teeth near the distal end.

Loc. Jem-Jem Forest, 8000–9000 feet, 24.ix.1926, 1 example.

It is evident that this form belongs to the group of *arcuatus*, Wahlgr., from the White Nile; but since the mucro is not so strongly curved, the last dental scale smaller, and there is only one single inner tooth on the claw, the present specimen is treated as a local variety.

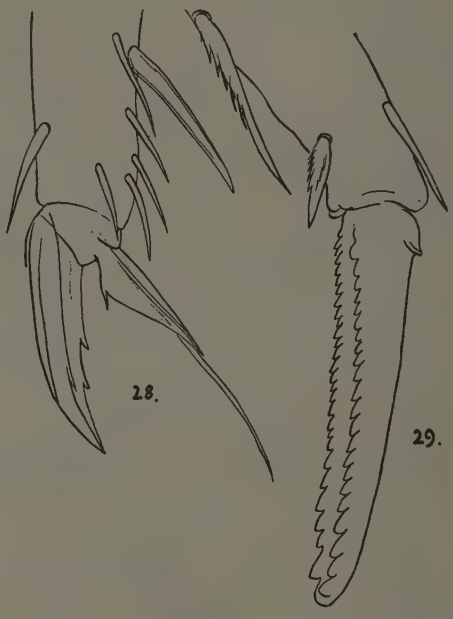
12. **Ptenothrix violaceus,** n. sp.

Diagnosis :—Length 2 mm. Body-colour yellow with dense diffuse violet pigmentation. Antennae, legs and manubrium dark blue. Ant. III, IV with annulations. Ant. III in the distal part with eight, Ant. IV with six, segments. There are straight, strong spines on the head round the eyes and on the frons, as also on the anal segment. Appendages and anterior portion of dorsum with long bristles which, especially on the inner side of the legs, turn gradually into strong thorns. General hairy covering stout, short.



Text-fig. 7.

Figs. 26–27.—*Cypoderus arcuatus,* Wahlgr., var. *aethiopicus,* n. var.
26. Claw.
27. Mucro.



Text-fig. 8.

Figs. 28–29.—*Ptenothrix violaceus,* n. sp.
28. Claw.
29. Mucro.

Claw with small tunica and two inner teeth. Lower claw with long, bristle-like appendage, extending beyond the apex of the upper claw. Inner edge with well-pronounced spine. Ventral tube long, with tubercles. Dentes with seven pectinate spines. Mucro with two equal, serrulated edges.

Loc. Jem-Jem Forest, 8000–9000 feet, 24–25.ix.1926, 9 examples.

Our knowledge of East African Collembola is scanty, as has been mentioned in the Introduction. From Egypt to Tanganyika Territory and Zanzibar in the South, and to the Seychelles in the East, only 69 species have been described. Of these, 15 are known to inhabit the highlands of Abyssinia, and these may

TABLE I.

	Egypt.	Sudan.	Erythraea.	Abyssinia.	Kilimandjaro.	Nyasa.	East Africa.	Seychelles.
Pseudachorutes mabirensis, Philipt.							×	
Pseudachorutes niloticus, Wahlgr.	×	×					×	
,, **mirabilis**, Handschin				×				
,, *flavoantennatus*, Philipt.							×	
,, **handschini**, Den.				×				
Linnaniemia gigas, Philipt.							×	
Achorutes montanus, Handschin				×				
,, *sokolowi*, Philipt.							×	
,, *sexoculatus*, Carp.								× ×
Axelsonia thalassophila, C. Börner								× ×
Proisotoma sjöstedti, Wahlgr.					×			
Isotoma bituberculata, Wahlgr.		×						
,, *lineata*, Wahlgr.	×							× ×
Isotomurus obscurus, Carp.								× ×
Entomobrya seychellarum, Carp.								× ×
,, *lanuginosa*, Nic. (Wahlgr.)	×							
Cremastocephalus scotti, Carp.								× ×
,, *celebensis*, Schäff.								× ×
Lepidocyrtus cyaneus, Tullb.	×			×	×			
,, *obtusus*, Wahlgr.		×						
,, *extensus*, Wahlgr.					×		×	
,, *fuscatus*, Wahlgr.					×			
,, *fülleborni*, C. Börner						×		
,, *lanuginosus*, Gmel.							×	
,, *silvestris*, Carp.								× ×
,, *obscuricornis*, Carp.								× ×
,, *annulicornis*, Carp.								× ×
,, *stramineus*, Carp.								× ×
,, *fryeri*, Carp.								× ×
,, *imperialis*, Carp.								× ×
,, *gardineri*, Carp.								× ×
Acanthurella braueri, C. Börner								× ×
Pseudosinella decemoculata, Wahlgr.	×							
Lepidocyrtinus traeghardi, Wahlgr.	×							
,, *incoloratus*, Wahlgr.	×	×						
,, *pulchellus*, Wahlgr.		×						
,, *jägerskjöldi*, Wahlgr.		×						
,, *flavovirens*, Wahlgr.		×			×	×	×	
,, *flagellatus*, Wahlgr.		×			×			
,, **coeruleus**, Den.				×				
,, **pseudocoeruleus**, Den.				×				
,, **subdomesticus**, Den.				×				
,, **aethiopicus**, Den.				×				
,, **cooperi**, Handschin				×				
,, **annulipes**, Handschin				×				
Mesira annulicornis, C. Börner						×		
,, *armillata*, Wahlgr.					×			
Pseudosira nyassica, C. Börner						×		
Paronella nigromaculata, Schött.				×	×		×	
,, *fülleborni*, C. Börner					×			
,, *coerulea*, Carp.								×
,, *flava*, Carp.								×
Dicranocentrus stachi, Den.				×				
,, *dogieli*, Philipt.							×	
,, *longicornis*, Carp.								×
,, *meruensis*, Wahlgr.					×		×	
,, **aethiopicus**, Handschin				×				
Cyphoderus assimilis, C. Börner	×							
,, *sudanensis*, Wahlgr.		×						
,, *termitum*, Wahlgr.		×						
,, **arcuatus**, Wahlgr.		×		×				
,, *insularum*, Carp.								×
Pseudocyphoderus squamicauda, Silv.			×					
Calobatinus rhadinopus, C. Börner			×					
Arrhopalites kilimandjarensis, Wahlgr.					×			
Sminthurinus niger, Lubb.	×							
Bourletiella spathacea, C. Börner.							×	
Ptenothrix violaceus, C. Börner				×				

be estimated as about 5–10 per cent. of the expected total of the fauna. As in other tropical countries we are far from knowing the whole fauna of Collembola and each expedition which collects these small, yet in zoogeography most important, Arthropods, is still able to bring new and interesting forms to our knowledge. In the catalogue of the East African species on p. 27 are traced the geographical affinities of the Abyssinian Collembola with respect to those of the surrounding areas.

As might be expected, it is quite evident that we must look for the closest affinities of the Abyssinian Collembola among the Collembolan fauna of the mountainous regions of the directly adjoining parts of the continent. There we find nearly identical species on the White Nile (*Cyphoderus arcuatus* and *Lepidocyrtus cyaneus* identical; *Lepidocyrtinus incoloratus* and *pulchellus* closely allied respectively to *Lepidocyrtinus subdomesticus* and *cooperi*). But also in the Kenya-massif and other parts of East Africa similar forms occur; *Lepidocyrtus cyaneus* and *Paronella nigromaculata* have also been recorded from this area, while *Pseudachorutes flavoantennatus* and *mabirensis*, with *Dicranocentrus meruensis* and *dogieli*, are closely similar respectively to *D. aethiopicus* and *P. mirabilis* and *handschini*. With the study of the present material from Abyssinia, the connexion of the hitherto nearly isolated fauna of the Seychelles with that of the African continent, becomes more firmly established.* *Heteromuricus longicornis*, being a *Dicranocentrus*, has its relations not in India, but on the African continent. This is also the case with the two species of *Paronella* (*Microparonella*) : six out of twelve described species of this genus occur in the African continent, three of them in its eastern part. *Cyphoderus insularum* belongs to the *arcuatus* group, it differs only in the absence of the medial spine on the mucro. *Acanthurella* and *Cremastocephalus* are the only true Asiatic-Papuan genera, and in possessing representatives of them the fauna of the Seychelles shows a remarkable distinctive feature.

As a special characteristic of the catalogue the enormous proportion of *Lepidocyrtinae* may be pointed out. They form together about 50 per cent. of the total of known forms but, as they include many critical species, perhaps the high number will be reduced somewhat by future research, and especially by recording more material from the lower groups of Collembola, namely the Hypogastriuridae, Achorutidae, Isotomidae and Symphypleona, of which only a few species are known from the region under review.

* This is remarkable, as in some groups of insects, particularly Coleoptera, the affinities of the endemic Seychelles fauna appear to be predominantly Oriental, African elements being almost entirely absent.—Hugh Scott.

THE TAXONOMY, PHYLOGENY AND DISTRIBUTION OF NEW ZEALAND CICADAS (HOMOPTERA)

By J. G. Myers, Sc.D., Imperial Bureau of Entomology.

[Read December 5th, 1928.]

Plates II–IV.

In 1921 the present writer contributed a revision of the cicadas then known from the Dominion, in 1923 several new species were added, in 1924 in a joint paper Iris Myers described the songs of the commoner species, and in 1926 a report was made on the examination of New Zealand types in European collections. In the latter year also, the puzzling mountain species were revised, several new songs and new species were described, and it was pointed out that in the genus *Melampsalta*, to which all the New Zealand forms belong, the best criteria for the separation of species lie in the structure of the aedeagus.

During and before the preparation of these papers, to which full reference is to be found in the bibliography, an intensive study was made of all aspects of cicada natural history. Most of the data acquired have been published in a volume on the family as a whole*; but certain sections which deal specifically with New Zealand cicadas and their own special problems are offered here. The present paper is intended to form a guide to the systematics, phylogeny and geographical and ethological distribution of cicadas in New Zealand. It should at least serve as a basis for the much-needed future work which the writer himself, absent from the Dominion, is no longer able to take up.

I. Taxonomy.

(a) *The genus* Melampsalta, *Kol.*

The genus *Melampsalta* is the largest and almost the most widely distributed genus in the family. Its members are often, moreover, the most abundant cicadas of a given locality. The headquarters of this genus of predominantly small and relatively unspecialised cicadas is undoubtedly Australia, which will probably be found to possess more species than all the rest of the world together. The Palaearctic region is also moderately rich in species, but fewer are known from the Oriental and Ethiopian regions, while the Nearctic possesses three species and the Neotropical apparently none.

In Australia especially, the genus has long been in a very congested condition, and attempts have been made to split off segregates worthy of generic rank. Such attempts have not been very successful, and I am compelled in this paper to sink one of them back into the parent genus. This is *Pauropsalta*, Goding and Froggatt (1904), separated almost solely on the two characters—head as wide as or a little wider than front of pronotum, and wing with five apical cells. The wider head occurs in some Australian *Melampsaltae*, while the narrower head is found in several Australian species which by venation belong to *Pauropsalta*. Davis (1920, p. 125) has declined to recognise *Pauropsalta* for

* *Insect Singers, A Natural History of the Cicadas:* London, 1929.

the American species, while Bergroth earlier (1911, pp. 188–189) condemned the venational character as useless. In the African *Melampsalta variegata* (Ol.) the latter author found six apical cells in some specimens and five in others. We suggest that the genus is invalid even for the Australian species.

Ashton (*in litt.*) considers *Melampsalta* an extremely difficult genus, comparable with *Paropsis* among Australian beetles. He writes (Sept. 16th, 1921), "I have begun to suspect that it is a genus in which tremendous variations occur, as happens in most dominant genera and species."

The characters of the genus *Melampsalta* may be briefly summarised as follows :—

Tymbals entirely naked (group character); head with eyes about as wide as anterior portion of pronotum, sometimes a little wider, occasionally a little narrower; vertex about twice as wide as an eye; front moderately or gently convex, with a medio-longitudinal sulcus distinct or obsolete; pronotum somewhat wider posteriorly than anteriorly, with the lateral margins obtuse, rarely somewhat explanate posteriorly; tegmen with Cu_1 fused with M for some distance beyond the arculus; ulnar and apical cells of tegmen subequal in length; wings with five or six apical cells; opercula small or medium; seventh sternite of female deeply and widely emarginate; periandrium with a feeble development of so-called "basal plates"; aedeagus deeply three-lobed. Size small to moderate.

Genotype : Cicada musiva, Germar, 1830.

Amyot (1847, p. 155) first used the term in the form *Melampsalte* (gallicised Greek) for one of his mononomial segregates, concerning the status of which there has been much discussion. On the very next page he proposed *Cicadette*, which is a synonym. Kolenati (1857, p. 27) established both these terms in the binomial system, but kept them distinct, giving page priority to *Cicadetta* (p. 19), (*Melampsalta*, p. 27). There are thus considerable grounds for the stand taken by Kirkaldy, Edwards and many continental Homopterists in refusing to recognise *Melampsalta*, save as a synonym of *Cicadetta*, which is credited to Kolenati. I prefer to follow general usage, established by the example of Stål, Karsch, Distant and Van Duzee in retaining the name *Melampsalta* for the genus in question.

The nineteen species now known from New Zealand all belong to this genus, and are almost certainly derived from a single immigrant form.

(b) *Keys to the New Zealand species.*

(1) General key for examples of either sex.

A. Hind-wings with six apical cells.
  B. Tegmen with infuscation at bases of cells $2R_3$ and $2R_5$.
    C. Tegmen usually 35 mm. or over; base of tegmen greenish . *cingulata*.
    CC. Tegmen usually 25 mm. or under; base of tegmen orange . *strepitans*.
  BB. Tegmen immaculate but suffused with colour.
    D. Tegmen suffused with green . . . . . *muta* var. *subalpina*.
    DD. Tegmen suffused with ferruginous . . . . . *campbelli*.
BBB. Tegmen immaculate and unsuffused.
    E. Apex of cell Cu_1 in tegmen very acute (under 45°).
      F. Length, male, 17 mm. or under; female 19 mm. or under. *scutellaris*.
      FF. Length, male, 19 mm. or over; female, 22 mm. or over . *cauta*.
    EE. Apex of cell Cu_1 more nearly obtuse (over 45°).
      G. A continuous median dorsal stripe from crown to apex of abdomen.

H. Base of tegmen and wing red, costa green . . *cruentata.*
HH. Base of tegmen and wing orange, costa yellow . *leptomera.*
HHH. Base of tegmen and wing not strongly coloured, costa reddish or brown . . . . *muta* and its var. *cutora.*
GG. Median stripe wholly or partially absent.
I. Colour vivid grass green; pronotum concolorous. *ochrina.*
I. Colour dark.
J. Conspicuous median stripe on abdomen only.
K. Length 21 mm.; tegmen = length (♀) . *fuliginosa.*
KK. Length 16 mm.; tegmen shorter than body-length (♀), equal (♂) . . . . . *campbelli.*
JJ. Conspicuous median stripe absent from abdomen.
L. Veins black, heavily marked . . . . . *nigra.*
LL. Veins normal.
M. Distinct pale median stripe on pronotum. *sericea.*
MM. Pronotum concolorous or at least lacking median stripe.
N. Black, with red segmental margins and more or less red suffusion of venter.
O. Length 19 mm. or over . . . *cassiope.*
OO. Length 15 mm. or under . . *iolanthe.*
NN. Black, with yellowish segmental margins; opercula and base of tegmina whitish.
P. Covered with golden pubescence; female, ratio of width between eyes to length of crown 0·84 . . . *mangu.*
PP. Covered with silver pubescence; female ratio, 0·77 . . . . . *oromelaena.*
NNN. Unicolorous dark grey; opercula (both sexes) black; base of tegmen orange. *hamiltoni.*
AA. Hind-wings with five apical cells.
Q. Colour blackish with red markings. *maorica.*
QQ. Colour black with fine gold pubescence giving *ensemble* a greyish appearance . . . . . *lindsayi.*

(2) Key to the males, based on the genitalia
(*maorica* and *fuliginosa*, known only in female sex, are necessarily omitted).

A. Aedeagus with lateral pieces very stout and extending far beyond middle piece and orifice.
B. Size large . . . . . *cingulata, strepitans.*
BB. Size small . . . . . *sericea, cruentata, leptomera.*
AA. Aedeagus with middle piece stout and extending well beyond lateral pieces.
C. Middle piece with two large distal spinous arms . . . . . *cauta.*
CC. Middle piece simple.
D. Lateral pieces feebly chitinised and extremely tenuous. *iolanthe, campbelli, hamiltoni, lindsayi.*
DD. Lateral pieces stouter, lance- or scimitar-shaped, strongly or moderately (*cassiope*) chitinised.
E. Lateral pieces scimitar-shaped.

F. Whole aedeagus short and stout . . *nigra, mangu, oromelaena.*
FF. Middle piece excessively long, fine and coiled . . . *cassiope.*
FFF. Middle piece stout, strongly curved and not exceedingly long. *muta, ochrina.*
EE. Lateral pieces lance-shaped . . . . . *scutellaris.*

The specific details of the genitalia are best appreciated from the figures.

(c) *Notes on the species.*

The first cicadas known from New Zealand were collected on Captain Cook's first voyage and described by Fabricius. One of the great navigator's company remarked on the " vast numbers of scorpion flies, with whose chirping the woods resound " (Cook, 1794, Vol. I, p. 153). Thus *cingulata*, *muta* and *cruentata* were named before the close of the eighteenth century. Boisduval added a synonym to *cingulata* when working on the " *Astrolabe* " collection, and Walker's entry into New Zealand tettigology was heralded by a second redescription of this large and common species. Most of the other abundant lowland species were named by Walker, often more than once. Wakefield and Hutton were the first to make known any of the mountain forms, the former sending a species to Buchanan White which received the name of *mangu* from the Maori term for black. Hutton published a list of twelve recorded species in 1874 and revised this in 1898.

Meanwhile a local worker had appeared on the scene, and G. V. Hudson published a separate paper on the group in 1891. The same indefatigable entomologist illustrated several species in his pioneer *Manual* (1892) and many others in the " Revision " of Myers (1921), while his collection supplied Kirby (1896) and Distant (summary, 1906) with the material for their revisory remarks on the nomenclature. Stål (1863) had previously dealt with the latter topic, and it was taken up again by Alfken (1904) and by Kirkaldy (1909).

We give below some notes on the nineteen species and the two varieties of cicadas at present known from New Zealand, but it has not been thought necessary to republish the original descriptions. Additional characters have, however, been drawn from the male genitalia, and these with the keys and illustrations should render identification moderately easy.

The male genitalia, and especially the aedeagus, serve admirably to separate the species into four main groups, which are characterised also by habitus and by ethology so markedly that they would be well worthy of subgeneric rank were the genus confined to New Zealand; but no such step should be taken until the genus has been revised on strict morphological characters through a greater part of its range and especially in Australia. We therefore call these groups by the name of a dominant species, and list them as follows :—

(1) The *Cingulata* group : The genitalia are very small and the lateral pieces of the aedeagus form their chief portion, extending far beyond the middle piece and the orifice of the penis. The characteristic shape of the whole organ varies but little in the five species and is met with outside New Zealand in *M. quadricincta* (Walk.), *melanesiana*, Myers, and *germaini* (Dist.) (Singh-Pruthi, 1925, Pl. XX, fig. 155), the first from Australia and the other two from New Caledonia. The aedeagus of the Oriental *Huechys sanguinea* (de Geer) (Singh-Pruthi, *l.c.*, fig. 151) is also apparently similar. The *cingulata* group divides firstly into the *cingulata* section containing the type species and *strepitans* —large stout species with dark coloration, a predilection for forest trees and bare lowland rocks respectively, and a habit of singing in chorus—and secondly

into the *sericea* section, comprising *sericea*, *cruentata* and *leptomera*—three small and, except the first, brightly coloured species addicted to a xerophytic environment either coastal (*leptomera*, *cruentata*) or inland (*cruentata*, *sericea*).

(2) The *Muta* group: The genitalia are strongly developed, with lance- or scimitar-shaped strong (save in *cauta*) lateral pieces and a long but stout middle piece carrying the orifice of the penis beyond the tips of the side pieces. This is the dominant group of New Zealand cicadas, occupying, with its various species, nearly every ethological station from the lowlands to an elevation of about 3000 feet. The *muta* section comprises *muta*, *ochrina*, *fuliginosa* and *scutellaris*—the first three very closely related and the latter somewhat isolated, though serving to connect with the *cauta* section, which contains but one species, notable for the practical atrophy of the lateral aedeagal pieces and the usurpation of their function by a pair of extraordinary distal, spinous, converging arms proceeding from the apex of the middle piece at the orifice of the penis.

(3) The *Nigra* group is made up of *nigra*, *mangu* and *oromelaena*, three closely related, predominantly black species exclusively alpine in distribution (3000 feet or over). The whole aedeagus is short and stout with strong, scimitar-shaped lateral pieces.

(4) The *Iolanthe* group: the whole aedeagus is extraordinarily attenuated, the middle piece long, thin and coiled sometimes almost like a watch-spring, while the lateral pieces are so extremely tenuous (slightly stouter in *cassiope* in keeping with its larger size) that they disappear completely on the briefest treatment with *KOH*. The abnormal tenuity of the lateral pieces is best seen in the *iolanthe* section which includes also *campbelli*, *hamiltoni*, *lindsayi* and almost certainly *maorica* (known only from the female)—five very small species strictly xerophytic in habitat and largely subalpine and lowland in distribution (up to 3000 feet). On the other hand, the extreme development of a long thin middle piece is seen in the *cassiope* section, confined to one alpine, xerophilous species (3000 to 4000 feet).

We list all the species below in the order best calculated to exhibit relationships. *Sericea* is nearest to and probably almost identical with the original immigrant form. Of the four groups derived from it, one, the *cingulata* group, is a direct development, while the others are apparently side branches arising from a common *muta*-like offshoot.

A complete synonymy will be given in my forthcoming list of the Cicadidae of the world. In the present paper only sufficient references are quoted to establish the nomenclature adopted.

1. **Melampsalta cingulata** (Fabr.).

Tettigonia cingulata, Fabr., 1775, *Syst. Ent.*, p. 690.
Melampsalta cingulata (Fabr.), Myers, 1921, *Trans. N.Z. Inst.*, Vol. 53, p. 241, Pl. 45, figs. 5, 6.

There is but little variation in this large and easily recognised species.

2. **Melampsalta strepitans** (Kirkaldy).

Cicada cingulata var. *obscura*, Hudson, 1891, *Trans. N.Z. Inst.*, Vol. 23, p. 51 (Nom. preocc.).
Cicadetta strepitans, Kirkaldy, 1909, *Canad. Entom.*, Vol. 41, p. 390 (N. n.).
Melampsalta strepitans (Kirk.), Myers, 1921, *Trans. N.Z. Inst.*, Vol. 53, p. 241, Pl. 45, fig. 7.

This is an even more uniform species than the last named, from which it may be distinguished by the smaller size, shorter wings, stouter build, orange wing bases, deeper, more trough-like and truncate, hairy hypandrium, and by

the genital differences figured. The base of the hindmost tibia is usually black, while in *cingulata* it is white.

3. **Melampsalta sericea** (Walk.).

Cicada sericea, Walker, 1850, *List Homopt. Brit. Mus.*, p. 169.
Cicada nervosa, Walker, 1850, *op. cit.*, p. 213.
Melampsalta indistincta, Myers, 1921, *Trans. N.Z. Inst.*, Vol. 53, p. 245, Pl. 46, figs. 7, 8.
Melampsalta sericea (Walk.), Myers, 1926, *Psyche*, Vol. 33, p. 62, Pl. 3, figs. 5, 6.

Sericea is essentially a northern species. The Auckland and Thames forms show little variation and are very like the types of *sericea* and *nervosa* in the British Museum. The males are uniformly darker than the females. Two males from Hawkes Bay (Hastings and Wairoa), from districts of smaller rainfall, are larger and considerably paler, differing from the type also in song. The male genitalia are, however, not sufficiently distinct to warrant specific rank.

A small dark male from Taranaki shows variation in the opposite direction apparently in response to very high rainfall.

4. **Melampsalta cruentata** (Fabr.).

Tettigonia cruentata, Fabr., 1775, *Syst. Ent.*, p. 680 (*nec* Myers *et auctt.*).
Cicada cincta, Walker, 1850, *List Homopt. Brit. Mus.*, p. 204.
Melampsalta cincta (Walk.), Myers, 1921, *Trans. N.Z. Inst.*, Vol. 53, p. 245, Pl. 45, fig. 11.
Melampsalta cruentata (Fabr.), Myers, 1926, *Trans. N.Z. Inst.*, Vol. 57, p. 686.

This is a strikingly marked little species remarkable for the extreme rarity of the female, of which I have seen only two specimens among hundreds of males observed or collected during a period of nearly eleven years. The startling contrast between the jet-black of the base and the blood-red of the apex of the abdomen is frequently obscured by copious silver pubescence, the relative amount of which may depend upon age, and to a slight extent on treatment after collecting. A very small form, not otherwise distinct, occurs at Mount White (coll. T. McLay !), Christchurch (coll. S. Lindsay !) and probably other parts of Canterbury.

5. **Melampsalta leptomera** (Myers).

1921, *Trans. N.Z. Inst.*, Vol. 53, p. 246, pl. 46, fig. 1.

Probably there is no mere coincidence in the fact that this little species is as uniform in coloration and other characteristics as the conditions of the ethological station to which it appears entirely restricted—namely, the fore-dunes of the coast, with their covering of marram-grass (*Psamma arenaria*) and pingao (*Scirpus frondosus*). The numerical proportions of the sexes are normal.

6. **Melampsalta muta** (Fabr.).

Tettigonia muta, Fabr., 1775, *Syst. Ent.*, p. 681.
Melampsalta muta, Kirby (part), Distant (part), Hudson (part) (*Cicada*), Hutton, Kirkaldy, *nec* Myers, 1921; Myers, 1926, *Psyche*, Vol. 33, p. 74; *Trans. N.Z. Inst.*, Vol. 57, p. 686.
Melampsalta cruentata, Myers *et al.*, 1921, *Trans. N.Z. Inst.*, Vol. 53, p. 244, Pl. 46, figs. 9–11.

I have said (*Psyche*, 1926) that this is a dominant species which has been and perhaps still is in an extremely plastic condition, mutating (?) right and left and occupying most of the less extreme ethological stations suitable for cicadas.

It is true that we have a great variety of stations and a corresponding multiplicity of forms in this protean species, but whether the above explanation of the connection between these two phenomena is the correct one we take leave to doubt. At least such an explanation is extremely unsatisfying and must ever remain so to the field naturalist. But this question is discussed at length in the next section.

The species is divided into the following three varieties.

Var. a. **muta** (Fabr.) as above.

Synonyms: *Cicada rosea*, Walker, 1850, *List Homopt. Brit. Mus.*, p. 220.
C. angusta, Walk., 1850, *op. cit.*, p. 174.
C. bilinea, Walk., 1858, *op. cit., Suppl.*, p. 34.
C. muta, Huds., and vars. *flavescens, cinerascens, rufescens*, 1891, *Trans. N.Z. Inst.*, Vol. 23, p. 51.

This is the commonest cicada in New Zealand, occurring in all types of country between sea-level and 3000 feet, save the fore-dunes of the coast and the recesses of the forest. It shows a stronger sexual dimorphism than any other New Zealand cicada, the males being small, always considerably blackish and frequently marked with bright red, while the females are larger and paler, usually showing some shade of pale green or buff, with a great restriction of the dark markings.

Two distinct types of variation occur in this variety—a colour variation of apparently no ethological significance, encountered among individuals of the same ecological station, and affecting chiefly the ground or hypodermal colour, leaving the pattern relatively unchanged; and a pattern variation, affecting the cuticular colours and strikingly correlated with hairiness, wing-length and ethological and geographical distribution. Hairiness would seem to be connected with altitude, since three specimens collected at Mount Cook at 2500 feet (R. J. Tillyard) and several taken at 3300 feet in the Tararua Mountains are distinctly more hairy than the lowland examples. This is borne out by the exceedingly tomentose covering of *Tettigarcta*, the primitive mountain cicada of Australia and Tasmania; and by the fact that all the New Zealand alpine cicadas are very hairy, as also is *muta* var. *subalpina*.

Both sexes of *muta* var. *muta* from the Chatham Islands, some 400 miles east of New Zealand, are very strongly suffused with black. The same condition, with the resulting suppression of all save the more salient of the paler markings, is seen in a male from the West Coast of the South Island. Both localities are notoriously wet; though the rainfall of the Chathams is not excessive, the number of rainy days is great. Buckton (1891, Vol. II, p. 190) has noticed the same tendency to melanism in Homoptera collected in Ireland, and I have discussed the question in earlier papers (1921, p. 250; 1924, p. 177).

Var. b. **subalpina** (Huds.).

Cicada muta var. *subalpina*, Hudson, 1891, *Trans. N.Z. Inst.*, Vol. 23, p. 51.
Melampsalta cruentata var. *subalpina* (Huds.), Myers, 1921, *Trans. N.Z. Inst.*, Vol. 53, p. 244, Pl. 46, figs. 12, 13.
Melampsalta subalpina (Huds.), Myers, 1924, *Rep. Austr. Ass. Adv. Sci.* (1923), p. 428.
Melampsalta muta var. *subalpina* (Huds.), Myers, 1926, *Psyche*, Vol. 33, p. 74.

Both this and the succeeding variety are remarkable for the absence of that great sexual dimorphism so characteristic of the parent form. In consequence, the divergence of the males from the typical variety is superficially very great, while the females are very hard to separate. Both sexes are a beautiful vivid

green, strongly reminiscent of the evergreen foliage among which they dwell, and ornamented with a variable extent of black markings. The essential characters are noticeable hairiness of body and a distinct green suffusion of the basal portions of the tegmina. Annectent forms which agree in colour with typical *muta* but in hairiness and suffusion with *subalpina* occur in the Nelson district, especially on and near the Dun Mountain, where the Mineral Belt, a long strip of peridotite and other magnesian rocks, brings practically a subalpine vegetation down to sea-level. Connecting links between *subalpina* and *cutora*, the next variety, occur in our experience only near Day's Bay, Wellington, perhaps the only locality in the North Island where *Nothofagus* forest descends to sea-level. There a form is present which has the habitus and hairiness of *subalpina* and the clear, colourless wings of *cutora*. In extent of dark markings it is strictly intermediate between these two forms. We have repeatedly heard a strange song at this locality—a song the first phrase of which is identical with a phrase of the song of *subalpina*, while the second phrase is reminiscent of part of the song of *cutora*—but we have so far failed to catch the singer in the act, for the insect shows a predilection for the higher branches of the beeches. It is probably the song of our intermediate form.

Var. c. **cutora** (Walk.).

Cicada cutora, Walker, 1850, *List. Homopt. Brit. Mus.*, p. 172 (*nec.* Myers *et al.*).
Melampsalta cruentata var. *subalpina* Myers *nec* Hudson, 1921, *Trans. N.Z. Inst.*, Vol. 53, p. 257.
Melampsalta muta var. *cutora* (Walk.), Myers, 1926, *Psyche*, Vol. 33, p. 75.

Just as *subalpina* connects *cutora* with var. *muta*, so *cutora* shows that *ochrina* is almost certainly derived from *muta*, though the result is sufficiently distinct to merit specific rank. Superficially *cutora* is much more like *ochrina* than like *muta*, but the series of transitional forms between the latter and *cutora* is complete, while intermediates in any sense between *cutora* and *ochrina* have yet to be found. The lack of hair and the restriction of black markings culminates, among the *muta* forms, in the condition seen in *cutora*. The wings are considerably longer in proportion to the body and the green suffusion is lacking in them. The space between the obconical black marks of the mesonotum, which are often reduced to mere hair streaks, is frequently red. The longitudinal pale mark on the pronotum is never lacking.

7. **Melampsalta fuliginosa,** Myers.

1921, *Trans. N.Z. Inst.*, Vol. 53, p. 245, Pl. 46, fig. 2.

This species is still known only from the unique female type. It may be an extreme aberration of *muta*.

8. **Melampsalta ochrina** (Walk.).

Cicada ochrina, Walker, 1858, *List Homopt. Brit. Mus. Suppl.*, p. 34.
Cicada aprilina, Hudson, 1891, *Trans. N.Z. Inst.*, Vol. 23, p. 53.
Melampsalta muta, Myers (*et al.*, *nec* Fabr.), 1921, *Trans. N.Z. Inst.*, Vol. 53, p. 243, Pl. 46, figs. 5, 6.
Melampsalta ochrina (Walk.), Myers, 1926, *Trans. N.Z. Inst.*, Vol. 57, p. 687.

The type is either a faded specimen, or, as seems more probable from the brightness of its yellow colour, an example of a colour mutation which I have taken in the field.

This unicolorous green species is perhaps the least variable of all New

Zealand cicadas. There is little sexual dimorphism, and both sexes are readily recognised by the uniform green colour relieved only by the gold or silver stripe along the dorsal line of the abdomen. *Ochrina* is extremely cryptically coloured among the glossy green leaves of the *Coprosma* and other shrubs which form its invariable haunt.

9. **Melampsalta scutellaris** (Walk.).

Cicada scutellaris, Walker, 1850, *List Homopt. Brit. Mus.*, p. 150.
Melampsalta scutellaris (Walk.), Myers, 1921, *Trans. N.Z. Inst.*, Vol. 53, p. 242, Pl. 46, figs. 3, 4.

The female is often strikingly like that of *cauta*, but always slimmer and smaller.

10. **Melampsalta cauta,** Myers.

1921, *Trans. N.Z. Inst.*, Vol. 53, p. 242, Pl. 45, fig. 8.

The male genitalia are extraordinarily modified and remarkably distinct.

11. **Melampsalta nigra,** Myers.

1921, *Trans. N.Z. Inst.*, Vol. 53, p. 247, Pl. 45, figs. 1, 2.

It may be noted that the brown suffusion of the wings mentioned in the original description is negligible compared with that of *subalpina* and of *campbelli*, where it is a good diagnostic character. The black and heavy venation is sufficient even apart from the male genitalia to distinguish this, the highest ranging of our alpine cicadas.

12. **Melampsalta oromelaena,** Myers.

1926, *Psyche*, Vol. 33, p. 65, Pl. 3, fig. 8.

This high alpine form is nearest allied to *nigra*, from which it is distinguished by its larger size and different aedeagus as figured.

13. **Melampsalta mangu,** F. B. White.

1879, *Ent. Mo. Mag.*, Vol. 15, p. 21; Myers, 1926, *Psyche*, Vol. 33, p. 67, Pl. 3, fig. 7; *ibid.*, *Trans. N.Z. Inst.*, Vol. 57, p. 687.
Melampsalta quadricincta (part), Myers (*et al.*, *nec* Walker), 1921, *Trans. N.Z. Inst.*, Vol. 53, p. 246 (but Pl. 45, figs. 3, 4, are true *cassiope*).

14. **Melampsalta iolanthe** (Hudson).

Cicada iolanthe, Hudson, 1891, *Trans. N.Z. Inst.*, Vol. 23, p. 53.
Melampsalta iolanthe (Huds.), Myers, 1921, *Trans. N.Z. Inst.*, Vol. 53, p. 247, Pl. 45, fig. 9; 1926, *Psyche*, Vol. 33, Pl. 3, fig. 13.

This is a very distinct little species, which appears to be becoming very rare, although apparently it was never common (Hudson). I have taken eleven typical females, but never a male. The normal Wellington male, of which I have examined specimens collected by Messrs. Hudson and Cockcroft, is strongly reddish, like the female; but a series taken by Messrs. Atkinson and Grimmett in the Orongorongo country east of the harbour (Wellington) are very blackish. This difference may be connected with habitat, which is normally clay banks, while the Orongorongo series was collected in a rocky river bed.

Iolanthe has a very characteristic shape—short and stout, with the abdomen tapering very suddenly to a point.

15. **Melampsalta campbelli,** Myers.

1923, *Trans. N.Z. Inst.*, Vol. 54, p. 430.
1926, *Psyche*, Vol. 33, p. 69, Pl. 3, fig. 12.

This species was founded on two rather bleached female specimens. In the second of the two references given above, the freshly caught female, the male and the song are described for the first time.

This is perhaps the South Island representative of *iolanthe*.

16. **Melampsalta hamiltoni,** Myers.

1926, *Psyche*, Vol. 33, p. 71, Pl. 3, fig. 11.

This very interesting species, apparently confined to unstable river-beds, is dedicated to Mr. H. Hamilton, who discovered the species at Arthur's Pass before we collected it there. It is very cryptically coloured on the grey river-bed shingle and is one of the most difficult of all New Zealand cicadas to locate. Both sexes and the song are described in the above reference, and the aedeagus figured.

17. **Melampsalta cassiope** (Hudson).

Cicada cassiope, Huds., 1891, *Trans. N.Z. Inst.*, Vol. 23, p. 54.
Melampsalta quadricincta, Myers (*et al.*, *nec* Walker), 1921, *Trans. N.Z. Inst.*, Vol. 53, p. 246, Pl. 45, figs. 3, 4 (exclusive of synonymy).
Melampsalta cassiope (Huds.), Myers, 1926, *Psyche*, Vol. 33, p. 72, Pl. 3, fig. 14; 1926, *Trans. N.Z. Inst.*, Vol. 57, p. 688.

In the *Psyche* reference the aedeagus is figured and the song described.

18. **Melampsalta lindsayi** (Myers).

Pauropsalta lindsayi, Myers, 1923, *Trans. N.Z. Inst.*, Vol. 54, p. 431.
Melampsalta lindsayi, Myers, 1926, *Psyche*, Vol. 33, Pl. 3, fig. 10.

Several other specimens have since been examined from near the original locality and all taken by Mr. C. Lindsay and his brother; and in addition I have seen a typical male in the British Museum with the label, " N. Zealand, H. Main, B.M. 1925–204."

The female is still unknown and may possibly be the next species, which is, however, very dissimilar in appearance. Both these forms are distinguished from all other New Zealand cicadas by possessing only five instead of six apical cells in the hind-wing—a character which should put them into *Pauropsalta*, Goding and Froggatt, but I have given elsewhere reasons for rejecting this genus. The male genitalia show *lindsayi* to be a member of the *iolanthe* group.

This diminutive cicada is no larger than our largest Cercopid, *Aphrophora* (*Cercopis*) *jactator*, F. B. White.

19. **Melampsalta maorica** (Myers).

Pauropsalta maorica, Myers, 1923, *Trans. N.Z. Inst.*, Vol. 54, p. 431.
Melampsalta maorica, Myers, 1926, *Trans. N.Z. Inst.*, Vol. 57, p. 688.

The type, a female, remains the only example known in collections.

II. Phylogeny.

The evolution of New Zealand cicadas.

The origin of Cicadidae in general, as indicated by palaeontology and by comparative morphology, I have discussed in a more general work.

Every species of cicada so far known from New Zealand is peculiar to the Maorian Region or Sub-region, which includes the three main islands of New Zealand, the Subantarctic Islands, the Chathams and the Kermadecs. Cicadas are known from the first (except Stewart Island), third and fourth of these groups. Since we have no reason to suppose that New Zealand is the birthplace of the family, it is interesting to seek the origin of the indigenous species. The literature on the land-connections between New Zealand and other areas, hypothetical or actual, is highly voluminous, but the geological and other evidence has been recently very ably summarised by Tillyard (1924) and applied to the solution of insect faunal questions. Tillyard (p. 413) postulates an early Austro-Malayan faunal element reaching New Zealand in the Jurassic; an early Antarctic connection during the same period; a second Austro-Malayan immigration in Upper Cretaceous to early Tertiary times; and finally a second Antarctic influx in the early Tertiary, since which time New Zealand has remained wholly isolated. The first, second and third of these contributions were shared with Australia, while the fourth was peculiar to New Zealand, Australia achieving her last "Antarctic connection" apparently during mid-Tertiary time, and receiving thus the ancestors of her rich Marsupial fauna. Another striking difference between the two countries lies in the absence from New Zealand of any element attributable to the Gondwanaland fauna developed in association with *Glossopteris* and represented in Australia by two distinct and primitive components.

The question is, from which of these sources New Zealand received her cicadas, if they did not arrive transoceanically. According to Tillyard (*l.c.*, p. 409) the insects which entered with the first Austro-Malayan immigration were "chiefly the more archaic Orthoptera, Coleoptera, and perhaps Diptera . . . together with a few Trichoptera and Lepidoptera Homoneura."

The first Antarctic element consisted of "a number of types of cold-climate and aquatic insects" such as mayflies, some dragon-flies, Perlids, some Trichoptera, and several families of Nematocerous Diptera. Cicadidae are not very probably present in this company, nor does New Zealand show any affinities with South America in this family. Moreover, we have no indication that true cicadas were then in existence. Turning to the second Austro-Malayan contribution we find (Tillyard, *l.c.*, p. 410) that by this means "New Zealand undoubtedly received the greater part of its insect fauna in the form of a stream of immigrants from the north, which passed down through New Caledonia by a continuous land-mass. This accounts for the many strong relationships shown between the faunas of New Zealand and of the tropical and subtropical forests of the Queensland and New South Wales coasts." Finally, by the second Antarctic connection New Zealand is supposed to have received her *Nothofagus* and *Fuchsia* trees and her Satyrine butterflies and Arctiid moths.

Only a single species of the New Zealand Cicadidae shows any relationship with foreign members of the genus. All the others are remarkably distinct. This one exception is *sericea*, which is closely allied to several Australian species, notably *quadricincta* (Walk.), and also to *melanesiana*, Myers, of New Caledonia. New Zealand males of *sericea* (= *nervosa*, Walk.), examples of *melanesiana* and

of the West Australian *quadricincta* were grouped as one species in the British Museum collection (1925), presumably by Distant. Perhaps the nearest relative of *sericea* is then in New Caledonia. *Sericea* is at present a xerophilous species in New Zealand, as are also its two relatives, *cruentata* and *leptomera*. We may then provisionally conclude, firstly, that a stock of cicadas structurally and ethologically resembling *sericea* came down the New Caledonia land-bridge and colonised both Australia and New Zealand in Upper Cretaceous or early Tertiary times. In Australia they found conditions very much to their liking, since, " in the early Tertiary Australia was taking form as we know it at present, and a dry continental climate had to a great extent developed " (Tillyard, *l.c.*, p. 411). Thus arose that dominant group of *quadricincta*-like *Melampsaltas* so plentiful in Australia to-day. As examples we may instance *latorea* (Walk.), *waterhousei*, Dist., *labyrinthica* (Walk.), *mackinlayi*, Dist., and *stradbrokensis*, Dist.

In New Zealand in the early Tertiary conditions were far otherwise. The country, though larger than at the present day, was too small to develop such a continental climate as that of Australia, and must therefore have been relatively moist. Thus the only species which is at present strongly reminiscent of the ancestral immigrant is restricted to the North Island, and even there is abundant only in the north. Since all the other New Zealand cicadas appear to be more closely related to *sericea* than to any foreign species, it is probable that they all arose from a single *sericea*-like ancestral form, which arrived as we have suggested above, but which lost in all save one segregate its *sericea*-like qualities in response to the peculiar and varied conditions of the ethological stations its descendants occupied one by one. Then surely we may say of these ancestral cicadas, as Cockayne has stated of the plant genera, *Celmisia*, *Veronica* (*Hebe*, etc.) and others, would they, " no longer held in check by uniform conditions, burst forth into that multiplicity of forms, some reversions, but others epharmonic changes in accordance with their diverse stations. Even yet the species-making is in progress." *

Unless we are prepared to admit a convergent development of *melanesiana* forms in New Caledonia, of *quadricincta*-like species in Australia, and of *sericea* itself in New Zealand, thus implying more uniformity in conditions in the three areas than the facts justify, it would appear that *sericea* has diverged remarkably little from the common ancestral stock which arrived in New Zealand in early Tertiary time. Two other explanatory possibilities present themselves: *sericea* or its very similar ancestor reached New Zealand more recently, and therefore of necessity transoceanically, and gave rise to the eighteen other species later; or *sericea* is still a recent arrival and the eighteen other forms are derived not from it or its similar ancestor, but from a previous and unknown immigrant along the New Caledonian land-connection.

Against the first of these two theories we must oppose firstly the enormous time probably required for the evolution of the diverse forms now occupying every suitable station in New Zealand, and secondly the sedentary habits of the Cicadidae and their unfitness in other respects also for oceanic transit. We must not, however, emphasise this apparent unfitness, for the presence of *cutora* in the Kermadecs is largely inexplicable on any other hypothesis than that of transit across some 1000 kilometres of open ocean. The Kermadecs are purely volcanic, and the form of *cutora* common there is identical save in wing-length with examples from New Zealand proper. This case is discussed in more detail later.

* L. Cockayne, *The Vegetation of New Zealand*. XIV Bd. in Engler and Drude's *Die Vegetation der Erde*, Leipzig and New York, 1921, p. 329.

The strongest evidence against the second possibility suggested above is the affinity of the other cicadas with the *sericea*-group, for if the original immigrant belonged to this same group, it would be far sounder to derive our modern *sericea* from it rather than postulate a later and trans-oceanic ancestor.

Suggesting then a single immigrant ancestral form very similar to *sericea*, we may trace the various and divergent lines of development brought about under the influence of the peculiar and varied New Zealand conditions.

Adducing first the evidence of the male genitalia, we find an essentially similar aedeagus in the New Caledonian *melanesiana*, in the Australian *quadricincta* and the Maorian *sericea*. This type is surely ancestral. *Cruentata*, *leptomera*, *cingulata* and *strepitans* still show a similar aedeagus, relatively unaltered. Of these all except *cingulata* have remained with *sericea* as nearly as New Zealand conditions would allow, in the ancestral xerophytic ethological stations. New Zealand is to-day prominently mesophytic and forested; so the distribution of such species, especially in the North Island, is strongly patchy. *Cingulata*, on the other hand, represents a form which made the discovery that tree-trunks offer in many respects a more favourable environment than banks and rocks. Of the five species of this group, this became the most successful, occurring in large numbers wherever the forest extends.

The remaining twelve species show two highly divergent lines of evolution, both leading, by gradual steps, to a type of aedeagus very dissimilar superficially to the supposed ancestral form. During this evolution we may envisage the ancestral cicadas extending their range gradually southward, changing as they went. On the one hand, we have eight species whose ancestors remained faithful to the original trait of xerophily, and occupied such xerophytic stations as they could find in a heavily forested land. In the North Island such stations are relatively rare: and to-day the group is there represented only by two species—*iolanthe*, which occupies in the southern extremity of the North Island similar spots to those frequented by *sericea* in the north; and *cassiope*, which occurs on Mount Ruapehu.

But when the xerophile stock reached the South Island it found in the lowlands east of the Southern Alps a considerable expanse of tussock country which enjoyed in Pleistocene times a more steppe-like climate than at the present day. It found also a large area above the timber-line on the mountains of the range, its foot-hills, parallel ranges and offshoots. What wonder then that it produced the numerous South Island forms of this group, colonising not only the open tussock plains, wide river-beds and other xerophytic stations of the lowlands, but also the mountain slopes, reaching its zenith in the hairy, short-winged, alpine cicadas of which the most specialised and widespread is *cassiope*! The development of the aedeagus accompanying this evolution took the form of an enlargement of the whole structure relative to the body size, a lengthening and thinning of all the parts and especially of the middle piece, and a reduction of the pieces in substance sometimes to excessive tenuity.

The other line of evolution took the form of a colonisation, hitherto accomplished only by *cingulata*, of the most widespread of all New Zealand plant-formations—the forest and its appendages. This would seem to have been a matter of considerable difficulty, for it took place very indirectly. The group to effect this colonisation consists of our remaining five species and their varieties, and constitutes the most characteristic element of the Maorian cicada fauna, besides containing all its most abundant species save *cingulata*. In this group the aedeagus most like that of *sericea* is borne by *muta*, through which, or through an extinct but similar form, the more extreme type, even that of

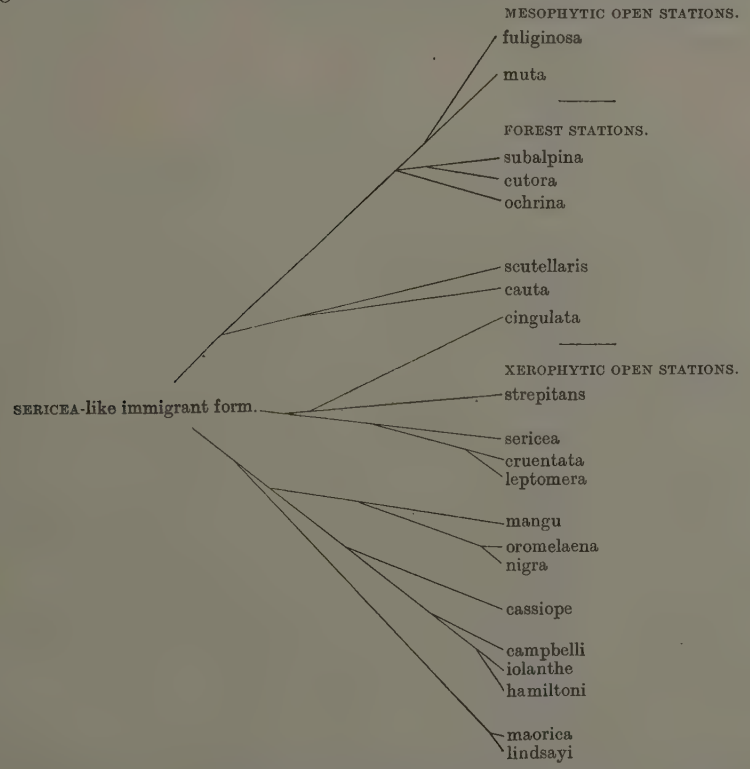
cauta, may be derived from the ancestral condition. *Muta* var. *muta* is, however, not a forest cicada; it is essentially addicted to a relatively mesophytic but open country habitat. *Muta* is remarkable for its wide range of stations—a range which has, however, been probably extended by the deforestation and grassing attendant on European colonisation. Be that as it may, *muta* at present occurs in both main islands and on the Chathams, from sea-level to over 3000 feet, wherever the environment meets the above ethological requirements. From such stations it was but a step to the forest undergrowth, and especially to the glossy-leaved evergreen shrubs of the forest fringe, wherever such a belt was encountered under the influence of edaphic or altitudinal factors, or more recently of partial deforestation, with its resulting second-growth. To such habitats are confined the three vivid green, highly peculiar Maorian forms —*muta* vars. *subalpina* and *cutora*, and the culmination, *ochrina*. The aedeagus of these three differs but little from that of *muta* in its typical form.

Finally, the deep recesses of a forest so dense and subtropical as the rain-forest of New Zealand offered the last stations to be occupied by such sun-loving insects as the CICADIDAE. *Cingulata*, the largest New Zealand species, retained to the full this sun-loving habit, which it was enabled to indulge by confining itself to the trunks and larger branches, but the smaller species, necessarily drawn to the smaller and thus more leafy and shaded twigs by the exigencies of feeding and oviposition, could exploit to the full the inner forest recesses only by abnegating part of that love for the sun which is apparently one of the most deeply-seated of cicadan traits. That this was a long and difficult process is indicated, we think, by the considerable divergence from the assumed ancestral type shown by the two essentially forest-dwelling species, *scutellaris* and *cauta*, in habitus and in aedeagal structure. The latter reaches its climax in *cauta*, where the side-pieces are almost completely atrophied and the copulatory hooks very small and slender, the function of both being apparently performed by two most unusual spinous arms diverging from the end of the middle piece. Both *cauta* and *scutellaris* show a greater tolerance of shade than do any other species, singing often not only in shady stations but also in cloudy or even actually wet weather when other cicadas are silent.

Another evolutionary trend in New Zealand cicadas has affected the length of the wings. There is, for instance, a complete gradation in this character in a series of *muta* var. *cutora* from the mainland, from Great Barrier Island near the coast and from the Kermadec Islands, 1000 kilometres to the north. The three lots are in most respects, including genitalic characters, practically indistinguishable, but the tegmina of the single Great Barrier specimen are longer than those of any member of a large series of mainland forms, while the Kermadec examples, of which fortunately a considerable number of both sexes was available, have longer tegmina than either. The ratios of body-length to tegmen-length in mainland, Great Barrier and Kermadec female examples respectively were 1 : 1·19, 1·24, 1·26. The tendency of insular races to exhibit either hypertrophy or strong reduction of wings is, of course, well known. It occurs also in the latter direction among the subalpine and alpine cicadas. Thus *muta* var. *subalpina* is invariably shorter-winged than its very similar relative var. *cutora*, the ratios being 1 : 1·10 and 1·19 respectively. The shortest-winged of all the species are the alpine ones; for instance, the ratio in *campbelli* female is 1 : 0·87. But the correlation is with openness of habitat rather than with altitude, since *muta* has shorter wings than either of its two shrub-haunting varieties, and *strepitans* has much shorter ones than its forest-dwelling relative *cingulata*. An interesting exception is furnished by *leptomera*,

which has very long but narrow wings, and is almost confined to the fore-dunes bordering the ocean and often abutting on high-water mark. Here the wind is usually blowing and is often strong. A flying insect is apt very readily to be blown either into the sea or inland into an unsuitable locality. It would seem that *leptomera* seldom takes the risk, since I have rarely seen it fly. When disturbed it "feigns death" in a most un-cicadan manner and drops to the ground.

In the taxonomic discussion of that protean species, *muta*, we have seen that intra-specific variation may take two forms—adaptive, or perhaps we should say directly correlated with environmental conditions, and mutational, or apparently not so connected. The former type is exemplified by the increase of hairiness with altitude, the extension of dark markings with rainfall, the association of a vivid green colour in both sexes in varieties (*cutora* and *subalpina*) confined to evergreen shrubs. That such variation is the form concerned in the origin of species among Maorian cicadas no one can reasonably doubt. In such a series as *muta-subalpina-cutora-ochrina* we seem almost to see the process in operation, for the changes involve not merely single characters but every attribute, morphological, ethological and psychological, of an organism.



TAXONOMIC AND ETHOLOGICAL RELATIONSHIPS OF NEW ZEALAND CICADAS OF THE GENUS *MELAMPSALTA*.

We have seen also, in discussing *muta*, that changes occur which may fitly be called mutations. They are exemplified by the occurrence of brilliant yellow varieties of normally green forms. So far as one can see these have affected no other character than the shade of the hypodermal colour. They have been recorded in several foreign cacadas also and in Orthoptera, in which green or greenish is the normal tint. We may instance *Dundubia intemerata*, Walk., in which Annandale (1900) found together two colour varieties, a green and a pale brown independent of sex. Moulton (1923, p. 86) thinks the brown form entitled to specific rank. The pink mutations in the usually straw-coloured (Kansas) or green (Florida) *Melampsalta calliope* (Walk.) and in *Pacarina puella*, Davis, are apparently analogous (Davis, 1925, p. 50).

Such changes may, of course, be purely individual and ontogenetic. Breeding records are not obtainable in the case of the cicadas. Whether this or that, however, they are almost certainly not concerned in species-making. The only New Zealand species which may be a mutation is *fuliginosa*, based perhaps unwisely on a single female, structurally very like a normal *muta*, but with the head and thorax entirely black. It was taken in a locality of only moderate rainfall where the *muta* females were of the normal, very pallid type.

To sum up this section we may attempt to express the relationships of New Zealand cicadas by the diagram on p. 43, designed to combine data furnished by morphology, ethology and music.

III. Geographical Distribution.

It has been shown that the New Zealand cicada fauna is wholly endemic, and it has been suggested that this fauna is derived from an immigrant species resembling *sericea*, entering the north. So far as the cicadas are concerned, New Zealand must be considered only a subregion of the Australian, from which it differs negatively in the paucity of species and especially of genera, as compared with the extraordinarily rich and varied cicada fauna of Australia, and positively in the development of two types which are found in *Melampsalta* nowhere else in the world. The first type is exemplified by *cutora* and *ochrina*, vivid green species closely associated with the evergreen shrubs in which the New Zealand flora is so rich, e.g. *Veronica* (*Hebe*), *Coprosma*, *Olearia*, *Metrosideros*. The second type is furnished by the high mountain cicadas associated with conditions which do not recur anywhere else in the Australian region save possibly in the mountains of New Guinea.

It is true that the units of cicada distribution are ultimately ethological, and, in fact, plant-associational, but since, as we shall see in the next section, the relation is with plant-associations rather than with plant-species, we must not expect too close an agreement of cicada distribution with that of the flora as indicated in Cockayne's botanical districts.

In studying the geographical distribution of organisms in New Zealand, one is at once interested to know how effective a barrier is afforded by Cook Strait, some twenty miles wide, separating North and South Islands. Many of the more typical North Island forms of Heteroptera extend their range to the northern part of the South Island, and this extension is paralleled by a similar distribution in the case of the plants. Thus Cockayne states:

"Strange as it may seem, Cook Strait forms no line of demarcation between the North Island and the South Island floras—so far at any rate as the lowland

region is concerned. It is not until latitude 42° South is reached that the South Island vegetation properly commences." *

Turning to another group of organisms—the birds—for evidence on this question, we are surprised to find that the Strait is apparently an effective barrier. *Heteralocha*, *Certhiparus* and *Notiomystis* are confined to the North Island, *Finschia*, *Mohoua* and *Notornis* (as a recent species), to the South. *Callaeas cinerea* (Gm.), *Turnagra tanagra* (Schleg.), *Myiomoira toitoi* (Less.) and *Miro australis* (Sparr.) of the North Island, are represented in the South Island by *C. wilsoni* (Bonap.), *T. capensis* (Sparr.), *My. macrocephala* (Gm.) and *Mi. longipes* (Less.) respectively. The restriction of such alpine forms as *Nestor notabilis*, Gould, and *Xenicus gilviventris*, Pelzeln, to the South Islands meets ready ethological explanation in the very much greater area of high mountain country in the South Island, but the above list, save perhaps *Notornis*, is not so explained. For the birds the Strait *is* a barrier.

We are constrained to ask how the CICADIDAE—also flying organisms—behave to this barrier. The twenty-one forms—discussing the two varieties of *muta* as separate entities—are distributed as follows :—

North Island only.	*South Island only.*	*Both Islands.*
sericea	campbelli	cruentata
leptomera	hamiltoni	cingulata
cutora (and Kermadecs)	oromelaena	strepitans
fuliginosa	mangu	muta (and Chathams)
ochrina	nigra	subalpina
scutellaris	lindsayi	cassiope
cauta	maorica	
iolanthe.		

Eight forms occur in the North Island, seven others in the South Island, and six remaining are common to both islands. Possibly further collecting will modify these figures. Here, however, is evidence that the cicadas are as much influenced as the birds by Cook Strait as a barrier. It is true that most of the South Island's endemism is related to the great development of alpine and subalpine conditions in that island, since at least five of the peculiar species are confined to mountains or to the wide stony river-beds associated with them, while only one truly alpine species, *cassiope*, reaches the North Island at all. On the other hand, the boundary certainly lies between the two islands rather than between mountains and lowland, for of the eight endemic North Island forms every one comes to the northern shore of the Strait, albeit in some cases rarely. Cook Strait is then the most important single barrier of the two main islands.

It will be extremely interesting, when more is known of the distribution of other New Zealand organisms, and especially insects, to ascertain how other groups behave towards a barrier so effective for birds and cicadas, so useless for plants. So ineffectual is it in the latter case that Cockayne makes his Ruahine–Cook Botanical District include the southern extremity of the North Island and the north-eastern corner of the South. That the CICADIDAE should be influenced differently from the Heteroptera is perhaps partly explained in our view, elsewhere elaborated, that there is a fundamental difference between the two sub-orders with regard to feeding-habits in phytophagous species—that

* L. Cockayne, "Some observations on the Coastal Vegetation of the South Island of New Zealand," *Trans. N.Z. Inst.*, Vol. 39, pp. 312–359, ref. p. 313.

whereas the Heteroptera show in general great specificity in host-plant preference and appear to be guided almost solely by the taxonomic affinities of the plants, the Homoptera rather seek special plant-associations than definite plant-species. Thus we should expect the Heteroptera to correspond in distribution with floristic units and the Homoptera with vegetational entities.

The distribution of Maorian cicadas may now be considered in somewhat greater detail. We have unfortunately had to omit from consideration previously published records concerning species the true systematic limits of which have been only recently elucidated. This applies also to our own previous records, which have been used here only when it was possible to confirm them by a re-examination of the actual specimens concerned. Such procedure has been necessary to ensure data of equal validity.

The New Zealand Sub-region consists of the two main islands, with the more southern Stewart Island as an appendage, and a number of outlying islands of which the chief are the Kermadecs, the Chathams and the New Zealand Subantarctic Islands. In addition there are numbers of smaller islands round the coast.

"The 1800 m. line includes the whole archipelago except Macquarie and Kermadec Islands, and, extending far to the north-west, it reaches to within comparatively close proximity to the Queensland coast, while Lord Howe and Norfolk Islands come just within its bounds." *

No cicadas are yet known from the Subantarctic Islands nor, surprising to relate, from Stewart Island. In the latter case the appearance of deficiency is probably due only to lack of collectors.

The common and apparently sole cicada of the Kermadecs, a northerly and isolated volcanic group, is *muta* var. *cutora*, which is plentiful among ngaio (*Myoporum laetum*, Forst. f.), a glossy-leaved tree very abundant also in New Zealand.† Now the Kermadecs are some 1000 kilometres from New Zealand proper, and are volcanic in origin, being in no sense remnants of the Austro-Malayan connection by which possibly the ancestors of the present cicadas came to New Zealand. We are therefore constrained to believe that the Kermadecs were colonised across 1000 kilometres of open ocean by this cicada. From a geographical point of view no other source is probable; from a phylogenetic standpoint any other theory would have to explain a remarkable case of convergence.

The Chatham Islands, lying some 700 kilometres east of Cook Strait, possess only one known cicada species. This is a deeply melanic form of typical *muta*, resembling in its black suffusion a form from the West Coast of the South Island, where the rainfall is very high. The rainfall of the Chathams is comparatively low, "but the number of rainy days, especially in winter, is excessive" (Cockayne, *op. cit.*, p. 42).

Of the cicadas of the coastal islets we know next to nothing. *Cutora* and *cingulata* occur on Great Barrier Island (Coll. D. Miller !). From Cuvier Island, some 65 miles east-north-east of Auckland, Mr. R. S. Sutherland has kindly sent me an imago of *cingulata* and two ultimate nymphs of *sericea*. The black scoria cone of the island volcano, Rangitoto, with its surprisingly complete covering of coastal forest-scrub, of which pohutukawa (*Metrosideros tomentosa*) is the most important element, supports the following tree- and shrub-loving cicadas—*cingulata*, *ochrina* and possibly *scutellaris*. Finally, of the islands in Cook Strait, Stephen Island, with its remarkable endemic bird and insect

* L. Cockayne, *The Vegetation of New Zealand*, Leipzig and New York, 1921, p. 23.

† Myers, 1921, p. 257, the cicada incorrectly listed as var. *subalpina*, Huds.

elements, and the Trio Islands, have been searched by Dr. Tillyard, who found on both a large cicada with a note like that of *cingulata* and a smaller but equally elusive species, neither of which could be caught for more definite identification (*Litt.*, 20, Jan. 1922).

An interesting case of discontinuous distribution is that of *cassiope*, which occurs on Mount Ruapehu, near the centre of the North Island, and is not seen again nearer than Mount Arthur, near the northern extremity of the South Island—and this in spite of the large intervening areas of apparently suitable country above the bush-line on the Ruahine Tararua-Rimutaka Ranges, where I have sought it in vain.

With regard to the mainland, we may summarise all the available data in the following tables, which show the distribution of the species as regards political provinces and botanical districts. For cicada material, used in compiling these data, I owe a debt of gratitude to almost every collector and entomologist in New Zealand, and to many who had not collected before. Records are based only on examples examined by myself.

1. *Cingulata*: Auckland: North Auckland, Auckland, Rangitoto, Thames, Great Barrier Island, Cuvier Island.
   Hawkes Bay: exact locality unknown.
   Wellington: Wellington, Wanganui, Tararua Ranges (up to 2000 ft.).
   Nelson: Lake Rotoroa, Mt. Arthur (up to 3000 ft., *teste* T. Cockcroft).
   Westland: Greymouth, Jackson's.
   Southland: exact locality unknown.

2. *Strepitans*: Wellington: Red Rocks near Sinclair Head, Wellington.
   Marlborough: Clarence River, Inland Kaikoura Mts.
   Canterbury: Mt. Grey, Sumner, Governor's Bay.

3. *Sericea*: Auckland: North Auckland, Auckland, Cuvier Island.
   Hawkes Bay: Hastings, Wairoa.
   Wellington: Wanganui, Paekakariki.
   Taranaki: exact locality unknown.

4. *Cruentata*: Auckland: North Auckland, Auckland.
   Taranaki: New Plymouth.
   Wellington: Ruapehu, Wanganui, Wellington, Orongorongo.
   Marlborough: Waiau, Kaikoura.
   Canterbury: Waipara, Christchurch, Mt. White, Governor's Bay, Cass, Ashley Gorge.
   Nelson: Farewell Spit, Nelson, Lake Rotoroa.

5. *Leptomera*: Auckland: North Auckland (Kaitaia).
   Wellington: Castlecliff (Wanganui), Levin, Paraparaumu, Wellington.

6. *Muta* var. *muta*: Auckland: Auckland, Thames, Volcanic Plateau, Waikato.
   Hawkes Bay: Hastings.
   Taranaki: Hawera.
   Wellington: Ohakune, Manawatu, Hunterville, Wanganui, Wellington.
   Marlborough: Blenheim.

CANTERBURY : Governor's Bay, Grey River, Waipara.
NELSON : Farewell Spit, Motueka, Nelson.
WESTLAND : Lake Kanieri.
(And in addition the Chatham Islands.)

7. *Muta* var. *subalpina* : WELLINGTON : Tararua Mts., Day's Bay, Wainui State Forest.
NELSON : Dun Mt., Mt. Arthur.
CANTERBURY : Arthur's Pass.
WESTLAND : Lake Kanieri.
OTAGO : Evansdale.
SOUTHLAND : The Hump, Hunter Mts.

8. *Muta* var. *cutora* : (Kermadec Islands).
AUCKLAND : North Auckland, Thames, Auckland, Waikato, Great Barrier Island.
WELLINGTON : Volcanic Plateau, Tararua Mts., Wanganui, Wellington.
TARANAKI : exact locality unknown.
HAWKES BAY : exact locality unknown.

9. *Fuliginosa* : WELLINGTON : Wellington.

10. *Ochrina* : AUCKLAND : North Auckland, Auckland, Waikato, Rangitoto, Great Barrier Island.
WELLINGTON : Wanganui, Wellington.

11. *Scutellaris* : AUCKLAND : North Auckland, Waitakere, Auckland, Volcanic Plateau.
TARANAKI : Mt. Egmont.
WELLINGTON : Wellington, Wanganui.

12. *Cauta* : AUCKLAND : Whangarei, Waitakere.
WELLINGTON : Wellington, Ohakune.

13. *Nigra* : CANTERBURY : Arthur's Pass.
(A doubtful female from Obelisk, Old Man Range, Otago.)

14. *Mangu* : NELSON : Dun Mt.
CANTERBURY : Porter's Pass.

15. *Oromelaena* : CANTERBURY : Mt. Cook.
OTAGO : Lake Wakatipu.
SOUTHLAND : Mt. Cleughearn (Hunter Mountains).
(Also a doubtful female from Arthur's Pass.)

16. *Iolanthe* : WELLINGTON : Wellington (Karori–Silverstream—Orongorongo).

17. *Campbelli* : MARLBOROUGH : French Pass.
CANTERBURY : Mt. Grey, White Rock, Mt. Cook.
WESTLAND : Otira.
SOUTHLAND : Waiau.

18. *Hamiltoni* : CANTERBURY : Arthur's Pass, White Rock, Ashley Gorge.
WESTLAND : Otira.

19. *Cassiope* : AUCKLAND : Mt. Ruapehu.
NELSON : Mt. Arthur, Dun Mt.
OTAGO : Mt. Ida.

20. *Lindsayi* : CANTERBURY : White Rock, Mt. Grey.

21. *Maorica* : NELSON : Nelson.

DISTRIBUTION OF N.Z. CICADAS ACCORDING TO THE BOTANICAL DISTRICTS OF COCKAYNE, 1921.

SPECIES AND VARS.	BOTANICAL DISTRICT.	Kermadec.	North Auckland.	South Auckland.	Volcanic Plateau.	East Cape.	Egmont–Wanganui.	Ruahine–Cook (North Island only).	North-Eastern.	Eastern.	North-Western.	Western.	North Otago.	South Otago.	Chatham.
Cingulata			×	×		×	×	×			×	×		×	
Strepitans								×	×	×					
Sericea			×	×		×	×	×							
Cruentata			×	×	×		×	×	×	×	×				
Leptomera			×				×	×							
Muta				×	×	×	×	×	×	×	×	×	×		×
Subalpina								×			×	×	×	×	
Cutora		×	×	×	×	×	×	×							
Fuliginosa								×							
Ochrina			×	×			×	×							
Scutellaris			×	×	×		×	×							
Cauta			×	×				×							
Nigra												×	?		
Mangu									×	×					
Oromelaena												×		×	
Iolanthe								×							
Campbelli										×		×		×	
Hamiltoni										×		×			
Cassiope					×				×		×	×			
Lindsayi										×					
Maorica									×						

IV. ETHOLOGICAL (ECOLOGICAL) DISTRIBUTION.

In New Zealand we find that the distributional characteristics of the twenty-one endemic cicadas of one genus epitomise those of the family throughout the world. The colonisation by the ancestors of one supposed immigrant species of every ethological niche even remotely suitable for cicadas is a phenomenon comparable to the occupation in the Hawaiian Islands by different species of the endemic bird family, the DREPANIDAE, of many diverse ethological stations commonly filled elsewhere by birds of as many different families.

Somewhat modifying the scheme adopted by Wheeler * for North American ants, we may distinguish the following ethological groups of New Zealand cicadas :—

1. Silvicolous or forest species. *Cingulata, cauta* and *scutellaris.*
2. Nemoricolous or forest-fringe and shrubland species. *Subalpina, cutora* and *ochrina.*
3. Cespiticolous or field species. *Muta, fuliginosa.*
4. Ericeticolous species, or those of dry open spaces and exposed banks. *Sericea, cruentata, iolanthe, lindsayi,* probably *maorica.*
5. Arenicolous species. *Leptomera.*

* W. M. Wheeler, *Ants, their Structure, Development and Behaviour,* New York, 1910, p. 157.

6. Saxicolous or lowland rock-dwelling species. *Strepitans*, *campbelli* and *hamiltoni*.

7. Rupicolous or mountain fell-field species. *Cassiope*, *mangu*, *nigra* and probably also *oromelaena*.

The variety of conditions within small areas in New Zealand is, however, so great, and the restriction of the cicada species to definite plant-associations so close, that we can classify with much greater detail than would be possible in a continental area. In the nomenclature of plant-associations we have followed the scheme set forth by L. Cockayne in his great work on New Zealand vegetation (1921, *op. cit.*). It is improbable that botanists will ever change the term "ecology" (oecology); but for reasons of general suitability and priority we use the term "ethology." "Ethology" (St. Hilaire, 1859), "oecology" (Haeckel, 1866) and "bionomics" (Ray Lankester, 1889) all form, as Wheeler has shown, a family of synonyms to which the latest addition is "behaviour" (Whitman, Lloyd Morgan, Watson).

Keeping in mind the major classification already proposed we may begin on the sea-coast and, proceeding ever inland and upward, review the cicada fauna as we go until we reach the snow-line.

On sandy coasts the first and immediately succeeding lines of dunes support a more or less scanty covering of the great orange-coloured sprawling sedge, pingao (*Scirpus frondosus*, Banks et Sol.). In places the European marram-grass, *Psamma arenaria* (L.), has been planted or is otherwise naturalised. Such is the only known habitat of *Melampsalta leptomera*. I have found it in association chiefly with these species and with *Spinifex hirsutus*, Labill. It is often extremely plentiful: one may see square feet of sand covered with a continuous layer of empty nymph cases. Yet it is so restricted to a narrow strip of fore-dune that it remained undiscovered even at the most populous watering-place of the capital city until 1920. In pingao patches it rests in the axils of the stout and convex leaves, where its orange colour marked with blackish renders it very difficult to see, while its shrill song is scarcely heard above the wave-beat on the adjacent shore. Where marram-grass is dominant the cicadas live deep down in the close tufts, sharing this curious domicile with the introduced snail *Helix aspersa* and the large Lycosid spider, *Dolomedes imperiosus*, which is probably responsible for the cicada corpses often found. As many as seven cicadas were found in one clump—in this case three males and two females, with two dead males. The more closely-growing (*i.e.* the older) the clumps the more cicadas they contain. The males sing at times from the very depths of the tufts. There is a single record of *leptomera* as far as one mile from the sea, singing in a tuft of toe-toe (*Arundo conspicua*, Forst. f.) which was half submerged in drifting sand. In this locality the inward drift of the dunes was proceeding apace. (Levin district, North Island, E. H. Atkinson !).

As the dunes become more stabilised numerous other plants appear; notably **Coprosma acerosa*, A. Cunn., *Calystegia Soldanella* (L.) R. Br., and in the Wellington district *Acaena novae-zelandiae* var. *pallida*. Here the near relative of *leptomera*, the red and black *cruentata*, is first seen at home. But this species is of far less restricted distribution. These stabilised dunes offer much less specialised conditions, and the ethological change from them to the tussock-grassland (Canterbury Plains), manuka heaths (*e.g.* east of Lake Taupo), river-beds and raised beaches is not great. In all of these stations *cruentata* is plentiful. Its range overlaps very little on the one hand that of *leptomera* and on the other

* I am deeply indebted to Mr. E. H. Atkinson for aid in the identification of plants.

that of *muta*, which prefers more mesophytic stations, of *sericea* and of *iolanthe*, which like clay banks and dry earthy situations, and of *strepitans*, which is addicted to cliffs and rock outcrops.

Cruentata is especially abundant on old raised beaches near Wellington. There are patches of *Coprosma acerosa*, clumps of *Scirpus nodosus*, Rottb., and occasional *Scirpus frondosus* and the yellow introduced poppy, *Glaucium flavum*, Crantz. *Cruentata* is almost always there in the clumps of *Scirpus nodosus*. If a dorsal view is obtained of the sitting insect, one sees that the median longitudinal white stripe assists protective resemblance among the upright *Scirpus* stems, the tips of many of which are pale, while old, dead stems may be almost white. Almost as soon as "spotted" the cicada moves round the stem, keeping this always between it and the observer. Then the pale whitish pubescent areas of the cicada's venter appear as an upright whitish stripe on each side of the sedge stem, giving altogether a very close resemblance to three adjacent parallel stalks, two of which are dead and white and lie one on each side of that supporting the cicada. Unless the insect is first perceived from its dorsal aspect, it almost always eludes notice in this position.

The rocks and cliffs of the bolder coasts often resound with the "loud chattering song" of *M. strepitans*. This stout, dark-coloured species is the rock counterpart of the tree-dwelling *cingulata*. It is by no means confined to coastal cliffs, but occurs where similar conditions are encountered inland, as, for instance, in stony river-beds. It does not, however, exploit the mountain slopes to any extent. I have records only from lowland stations. At one locality near Wellington, where an open karaka (*Corynocarpus laevigata*, Forst.) grove occupies a hollow at the top of the cliffs, both *strepitans* and *cingulata* occur in some numbers together, the former perching and singing on the boulders and cliff faces, and the latter keeping to the tree-trunks. *Strepitans*, however, did not disdain to perch on dead and prostrate logs occasionally, and even on tree-trunks.

Sericea is the common cicada of gumlands heath in the South Auckland Botanical District. This is a characteristic association of shrub heath. "In winter it becomes saturated with water, but in summer, baked by the sun, it is extremely dry and opens out into many cracks" (Cockayne, *op. cit.*, p. 150). *Sericea* is more abundant in this than in any other stations, and as it extends its range southward, beyond the area of this plant association, suitable habitats become less extensive and the insect correspondingly rarer. In Hawkes Bay and in the Wanganui district of Wellington Province, it occurs on clay banks and in sparse hill pastures where deforestation and consequent erosion, assisted by stock, have left considerable bare areas. Roadside banks and cuttings may be also frequented. It and *iolanthe* are the only lowland cicadas I know which frequently rest on the ground itself, where no elevations are present. It perches sometimes on buildings, low plants, tree trunks and bare posts, and at the height of its abundance (end of December) occurred in the city of Auckland on the surface of the main streets in the centre of the town. Males were observed singing vigorously on the glaring white side of a house in the sun, where their black coloration made them very conspicuous.

Iolanthe is found on similar clay banks, cuttings, paths and washouts in the Wellington district, and occurs also in the rocky river-beds which descend precipitously to the sea on the east of the harbour. Both sexes rest on bare ground, but sometimes on rocks and more rarely on logs.

The tiny cicada, *lindsayi*, would appear to favour similar situations in the South Island. For specimens and information concerning it I am indebted

to Messrs. S. and C. Lindsay, who state that on clay banks in the sun the insect is almost invisible. The merging process is assisted by the covering of golden pubescence. *Maorica* perhaps resembles *lindsayi* in ethological distribution, but field notes are lacking on the unique type.

As might be expected, the great river-beds of the South Island support a number of peculiar species, besides examples of *strepitans* already mentioned. The most interesting and specialised form is *hamiltoni*, a little uniform grey cicada occurring on shingle flats almost entirely bare of vegetation. There the males sit on grey smooth stones, and though singing with energy, are perhaps more difficult to detect than any other insect I have collected. This station would border the unstable river-bed (*Epilobium-Raoulia*) association of Cockayne (*op. cit.*, p. 164), but where the adults occur there is usually practically no vegetation. Unfortunately the life-history of *M. hamiltoni* is completely unknown. This species occurs up to 2000 feet elevation on the eastern (drier) side of the Southern Alps (Arthur's Pass).

Campbelli favours stabilised river-bed associations, both the eastern more xerophytic (p. 164) and the western (p. 165) types of Cockayne. It occurs up to an elevation of 2500 feet. A station at Otira, of the western river-bed type, and at an elevation of 1650–1700 feet, supported the species in considerable numbers and may be described as characteristic. Olive-green moss covered half the boulders, while the open spaces between were filled with several introduced weeds—*Hypochaeris*, *Holcus*, *Rumex*, *Prunella*, *Aira* and even *Trifolium*—dominated by *Coriaria angustissima*, Hook. f., *C. sarmentosa*, Forst. f. and *Acaena microphylla*, Hook. f. In places were masses of a grey branching lichen and of *Raoulia haastii*, with plants of *Veronica lyallii*, Hood. f., while a brilliant red powdery alga bespattered the boulders, occasionally forming continuous and extensive bloody patches. The latter, with the reddish leaves and heads of the piripiri, the red stems, young leaves and unripe berries of the tutu, combined with the general leaf tint to produce a picture predominantly crimson and green, matching the brilliant colours of this little cicada, which, especially in the female sex, was extremely difficult to discover.

A hundred feet higher up the Otira river-bed less vegetation was present as the bed narrowed, but nearest the bank was a limited replica of the association occurring further down. Here *campbelli* was also common. Nearer the water was plain bare shingle as under more xerophytic conditions on the other side of the Pass, and on these grey naked stones *hamiltoni*, absent on the stabilised part of the bed, was present in some numbers. There appeared practically no overlapping between these species.

Still in strictly lowland plant-formations we come now to a case less clear-cut than the foregoing examples. *Muta* is perhaps the commonest cicada in New Zealand at the present day. It is essentially attached to herbaceous plants, which it uses both for perching and for oviposition. It occurs only in open country, but eschews the more xerophytic stations hitherto considered. Open country with mesophytic conditions forms, of course, the ideal of the settler, and the colonisation of the Dominion, as of other temperate lands, has consisted very largely in an extension of such areas. So here we appear to have a case in which settlement has for once been favourable in its effects on an indigenous form. In other words, the area of country ethologically suitable for *muta* has been increased to an enormous extent by agriculture, and there seems no reason to doubt that this cicada has multiplied and extended accordingly. The question arises as to which formation supported *muta* in primitive New Zealand. It was decidedly no kind of forest association. Heath, river-bed and some tussock

grasslands were either climatically or edaphically too xerophytic. Low tussock grassland or *Poa-Festuca* association (Cockayne, *op. cit.*, p. 168) may have been one original home. There remain swamp and moor associations as possibilities, and judging by the present occurrence of *muta* I am inclined to view the former as also one of its primitive habitats. *Muta* is to-day extremely common in pastures and roadsides.

Fuliginosa—the single type specimen was taken in a *muta* locality and is probably only an aberration.

Subalpina, a variety morphologically very close to *muta*, the parent type, but ethologically greatly divergent, introduces us to three vivid green forms which have apparently developed from *muta* in response to the environmental conditions afforded by the great wealth of evergreen shrubland associations in New Zealand. All three are essentially devoted to woody plants. *Subalpina* occurs in the South Island and in the southern extremity of the North, almost solely in shrubland associations, usually those on the tops of lower hills, where edaphic or other conditions have produced scrub, or those which separate the upper limits of the forest from the alpine fell-fields and herb-fields. We have not known typical *subalpina* below an elevation of 1000 feet. Consequently stations where the range of *subalpina* might overlap that of the parent form are rare, and intermediates between the two were lacking until we obtained specimens from the Nelson Mineral Belt, where an interesting condition disclosed itself.

" The belt," we quote from Cockayne (*op. cit.*, p. 334), " is a narrow, stony tract, consisting of peridotite and serpentine rocks, extending for about 96 km. from D'Urville Island to Nelson with its widest part (about 5 km.) in the vicinity of the Dun Mountain. The vegetation of the belt, both in its density, its associations and its growth-forms, presents a striking contrast to that of the adjacent luxuriant *Nothofagus* forest. The transition from forest to mineral belt vegetation is hardly to be seen, each standing out distinct. Not only does the magnesian soil influence the associations but it changes the growth-forms, so that trees beyond its influence are mere shrubs on the belt. . . . The associations of the belt consist of shrubland, fell-field and tall tussock-grassland. . . ."

Here were found all types of intermediates between the type form of *muta* and the variety *subalpina*.

Subalpina occurs up to an elevation of 3300 feet in the Southern Alps at Arthur's Pass.

The other green variety of *muta*, namely, *cutora*, is a further step towards *ochrina*, which is *par excellence* the lowland shrubland cicada. *Cutora* is found at no such elevation as *subalpina*, and is, moreover almost entirely northern in distribution. The chief known station where it overlaps the range of *subalpina* is Day's Bay, near Wellington, where true *subalpina* occurs on the ridge at an elevation of about 1000 feet, where the *Nothofagus* forest is reduced by wind to a shrubland association, with *Dracophyllum*, *Gaultheria rupestris* (Forst. f.), R. Br., and *Weinmannia racemosa*, L., verging practically on scrub. *Cutora* occurs in the open portions of the forest itself and in the second-growth shrubland of the lower slopes. Several strict intermediates have been taken on the summit, and a song annectent in character heard on the slopes at York Bay, a mile or so further north. *Cutora* is frequent also on gumlands heath, and in short almost anywhere that shrubland associations occur at low levels in the North Island. It is found abundantly in young second-growth forest and among shrubs grown as hedges and ornaments in parks and gardens.

Even more addicted to the latter types of ethological stations, but more restricted geographically, is the beautiful green immaculate *ochrina*, for long known only from the Wellington Botanical Garden (Mr. G. V. Hudson). Both this and *cutora* frequent introduced as well as indigenous shrubbery. On the recent volcanic cone, Rangitoto, where the otherwise bare black scoria blocks support a plentiful growth of bushes and small trees, *ochrina* is especially abundant.

We have now to deal with three species which are pre-eminently forest-dwellers. *Cingulata*, our largest cicada, occurs sometimes in large numbers wherever, in North and South Islands, forest is found. It makes little or no distinction between almost subtropical rain-forest and the more xerophytic *Nothofagus* woods. On the eastern side of the South Island, where tussock grassland is the prevailing association, its place is largely taken by *strepitans*. But *cingulata* by no means demands extensive forest—only sizeable trees. Thus in the far north it abounds on the pohutukawas (*Metrosideros tomentosa*) of the coastal cliffs, and I have heard a deafening chorus from clumps of mangroves, *Avicennia officinalis*, L., standing at high tide in several feet of salt water and separated by a considerable stretch from the true shore line. As in the case of *ochrina* and *cutora*, introduced trees are by no means disdained, and the abundance of *cingulata* in settled districts, in spite of the ravages of the English house-sparrow, may be gauged by the fact that Mr. T. Cockcroft counted no fewer than 436 nymphal cases on the trunk of one willow tree in the Waikato. *Cingulata* is found even on gumlands heath where introduced trees have been planted, or *Leptospermum ericoides* attains arboreal dimensions. On Mt. Arthur *cingulata* occurs up to an elevation of 3000 feet (*testé* Mr. T. Cockcroft); in the Tararuas 2000 feet. The only example I have ever seen perched on a rock was a cripple which could not fly.

Far more essentially sylvan, though less confined to the actual tree-trunks, are *cauta* and *scutellaris*. We have already indicated that these two species have become relatively tolerant of shade. They are the only cicadas habitually found in the recesses of the forest, though *cauta* is perhaps more abundant on borders and in natural and artificial clearings. Neither form appears to extend much above 1000 feet altitude. Unlike *cingulata*, both these species commonly settle on branches of the undergrowth, or even on ferns and grasses. *Cauta* occasionally rests on logs and tree-trunks—*scutellaris* apparently only on twigs, especially of the undergrowth.

Leaving the cicada fauna of the lowlands and lower hills we have now four species confined to mountains. My work in the alpine regions of the South Island, to which these species are practically confined, has been extremely limited, and I am unfamiliar with two of the forms in the field—*nigra* and *oromelaena*. All four species occur chiefly well above the bush-line and are doubtless, as indicated by male genitalic structure, derived from xerophilous lowland ancestors which colonised the higher mountain slopes by way of the wide river valleys, and left in these latter, to mark the route, such typical and related species as *campbelli* and *hamiltoni*.

Cassiope is the most abundant and widely distributed, but its altitudinal range begins and ends lower than that of any of the others save *mangu*—at least in the South Island, where several of the species may occur on the same mountains. In the North Island it has been taken above 6000 feet elevation on Mt. Ruapehu (Mr. T. R. Harris !), but at Arthur's Pass we found it no higher than 3500 feet altitude, while its lower limit there, at about 3200 feet, sometimes entered among the stunted beeches (*Nothofagus*) at the upper forest line. In

the north of the South Island I have examples from 4000 feet on Mt. Arthur (Mr. T. Cockroft !), where here also they reached just down to the topmost beeches, the lower latitude making the bush-line higher. *Cassiope* would appear to be more tolerant of vegetation than the other three species. Its station may be defined as herb-field (Cockayne, *op. cit.*, p. 241), while the others, *mangu* and *nigra*, and probably *oromelaena*, are essentially fell-field or even rocky debris forms.

Mangu was described from Porter's Pass, elevation 3500 feet. Specimens referred to this species were taken on the Dun Mountain, Nelson, at altitudes varying from 2500 to 3500 feet, always on relatively bare areas, sometimes so nearly devoid of vegetation as scarcely to merit the name of " fell-field." In every case they were resting on bare rock, where they were extremely difficult to distinguish even with the guidance afforded by the song.

Nigra is another rock-haunting species found by its discoverer, Mr. G. V. Hudson, at an elevation of about 5000 feet at Arthur's Pass—thus well above the alpine line. The collector writes : " On eastern side of Arthur's Pass (4500–5200 ft.) there are shingle-patches and mountain-grass interspersed. Here a new species of cicada was abundant."

Oromelaena, judging from its elevated range, is probably also a fell-field species. I have material taken at the following elevations—3600 to 4000 feet (Mr. G. V. Hudson, Lake Wakatipu), 4500 feet (Dr. R. J. Tillyard, Mt. Cook). Previously published altitudinal records for the alpine and subalpine cicadas of New Zealand are to be disregarded, since the species were not then correctly differentiated.

We may conveniently summarise this section by listing the plant-associations with the cicadas associated with each.

Plant formations.	*Cicadas.*
A. Coastal :	
1. Dune and strand.	Leptomera, cruentata.
2. Coastal rock and cliff.	Strepitans.
3. Mangrove swamp.	Cingulata.
4. Coastal scrub.	Cutora, ochrina.
5. Coastal forest.	Cingulata, scutellaris.
B. Lowlands and low hills :	
6. Lowland forest.	Cingulata, cauta, scutellaris, cutora, ochrina, subalpina (shrub).
7. Heath.	Cruentata, sericea, cutora (shrub-heath), iolanthe, lindsayi, maorica ?
8. Swamp.	Muta.
9. River-bed.	
a. Unstable.	Strepitans, hamiltoni.
b. Stable.	Campbelli.
10. Grassland.	Muta, fuliginosa.
11. Rock.	Strepitans.
C. High mountains :	
12. Shrub associations.	Subalpina.
13. Herb-field.	Cassiope.
14. Stony debris and fell-field.	Mangu, nigra, oromelaena ?.

Effects of Settlement on the indigenous Cicada Fauna.

An interesting question may be raised as to the effects on the indigenous cicadas of the colonisation of New Zealand with its tremendous alteration of the environment.

In North America (Webster, F. M., 1897), in Australia (Cleland, 1918), in New Zealand (Hudson, 1891), especially in the vicinity of cities, the English sparrow is a very serious enemy of cicadas. In fact the three authors cited above regard the sparrow as the chief agent in the partial extinction of cicadas, or certain species of cicadas, in such localities. It is, however, only fair to add that while these birds are as plentiful as ever in the neighbourhood of Wellington, New Zealand, where Hudson's observations were made, the chief cicada concerned, *Melampsalta cingulata*, is still a common insect; and thus we may be in the presence of one of those restorations of balance which do sometimes occur between members of an indigenous fauna and the disturbing changes of colonisation.

The method adopted by the sparrow in dealing with such a large insect is well described by Fabre (1921). In New Zealand we have seen this bird with a *Melampsalta ochrina* held in its beak by the tips of the closed tegmina, and thus evidently seized while resting—surely an adroit feat. The sparrow was swinging the incessantly shrieking insect over its head and banging it violently and repeatedly upon the ground. *Ochrina* is almost our most cryptically coloured cicada; one may look for five minutes only two feet away from a singing male and fail to locate it.

I have also seen a sparrow catch *Melampsalta muta* on the wing. An example of this insect which I had disturbed was taken in flight by a sparrow after a very short chase, but the bird had to alight immediately to deal with its bulky prize. Mr. Cockcroft has seen it capture even the much larger *M. cingulata* in the same manner.

I doubt very much whether birds trace cicadas by the song as Distant and Swinton have suggested. The behaviour of the sparrows where cicadas are plentiful seems rather to consist in keeping a sharp look-out for the movements which, in hot sunny weather, are frequent among both sexes of, for instance, *M. cingulata* and *M. muta*. The observation of Swinton (1880, p. 21), that " certain greyish insectivorous birds " deliberately twittered in order to provoke from the cicada a response which would betray its whereabouts, reads altogether too like a fairy tale to receive serious consideration. Yet I find this note in one of my old note-books (October 29th, 1915), that the " cat stalks cicadas (*M. muta*) in the grass, by their chirping, catches and eats them even to the wings." As I remember it now, this was quite a habit of one of our cats, and its behaviour certainly gave all the outward signs of listening rather than of searching by visual means alone.

As we have seen, the activities of the sparrow are considerably restricted to the vicinity of towns. We may proceed now to consider the environmental factors, which if more passive are also far more widespread. The influence of changed environment as a whole can only be inferred indirectly. According to the supposed effects the cicadas may be divided into the following classes :—

1. *Species as yet unaffected by settlement*: Here may be placed all the high mountain forms, and probably also *campbelli* and *hamiltoni*; perhaps also *strepitans*.

2. *Species the primitive stations of which have been extended by settlement*: *Muta, sericea, cruentata, iolanthe*; possibly also *lindsayi* and *maorica* if we knew

more about them. An analogous case in the avifauna is that of the pipit or ground-lark, *Anthus novaeseelandiae*, Gm.*

3. *Species and varieties the primitive stations of which have been* MATERIALLY DECREASED BY SETTLEMENT: *Cingulata*, *cauta*, *scutellaris*, *subalpina*, *ochrina*. All of these have adapted themselves more or less to second-growth forest and semi-cleared land. The habitat of *subalpina* has been the least spoiled. *Cauta* shows the least tendency to adapt itself to the new conditions and has not yet been recorded save from primitive forest or from immediately adjacent cut-over land. *Scutellaris* and, much more, *ochrina* occur plentifully in second-growth, in shrubberies, plantations and even parks and gardens.

4. *More complex cases*: *Cutora* might easily go into both (2) and (3). Its shrub-heath stations have been tremendously extended by colonisation and the resulting spread of manuka, *Leptospermum scoparium*, Forst., and of European gorse, *Ulex europaeus*, L. Its forest haunts, on the other hand, have been seriously tampered with, but like *ochrina* it is much at home in second-growth and among the shrubs of parks and gardens.

Leptomera should perhaps be listed in (2). The primitive station has not been extended to any great extent, but it has been in certain localities altered by the introduction of the sand-binding grasses, especially *Psamma arenaria*. In so far as this plant forms a relatively climax association the result is an advantage to the cicada, since in regions where marram-grass occurs, this plant has been adopted as a favourite shelter and oviposition host and probably food-plant; but in so far as marram is a step towards a stabilisation of the dunes it represents an influence inimical to the insect's welfare, for *leptomera* lives only on unstable dunes.

By a thorough search of the literature I have been able to find only a very few references to the effects of colonisation or other environmental changes upon indigenous cicada faunas. These references concern the famous periodical cicada (*Magicicada septendecim* (Linn.), which is apparently doomed to extinction with the passing of forests (F. M. Webster, 1897; Marlatt, 1907, summary), and two others, one in Australia (Goding and Froggatt, 1904, p. 570) and one in Central Europe (Leydig, 1902, p. 112). Goding and Froggatt state that the large *Cyclochila australasiae* is common in Sydney surburban gardens, and has thus apparently in a large measure adapted itself to the altered conditions. Leydig mentions the former abundance of *Tibicina haematodes* in the vineyards of Würzburg, and adds:

"Jetzt ist das Thier zur Seltenheit geworden und auch der volksthümliche alte name 'Lauer' fängt an sich zu verlieren."

This he attributes partly to the altered methods of vine-cultivation and possibly also to "allgemeine kosmische Einflüsse, da das Auftreten der Cikade immer mit wirklich guten Weinjahren zusammen fiel, solche aber seit Längerem ausgebleiben sind."

A dismal picture is painted of the future of the well-known seventeen-year cicada. Will it too disappear like that other swarming inhabitant of the North American forests, the passenger pigeon (*Ectopistes migratorius*)? Wherever the woods are cleared it seems certain that this cicada must go—and it is in just such places that the work of destruction is most assisted by the English sparrow. Some of the well-recognised earlier broods appear now to be practically extinct; and each brood represents a definite and almost calculable proportion of the total strength of the species.

* J. G. Myers, "The Present Position of the Endemic Birds of New Zealand," *N.Z. Journ. Sci. Techn.*, Vol. 6, pp. 65–99, 1925, p. 96.

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Explanation of Plates II–IV.

N.B.—Figures 25 to 45 are drawn from balsam-mounted KOH material checked with the aid of unmounted preparations. All these were drawn with a projectoscope, the magnification of 25 to 37 inclusive being exactly twice that of 38 to 45. This indicates the great relative size of the genitalia in the alpine groups. All figures are of the male genitalia.

Plate II.

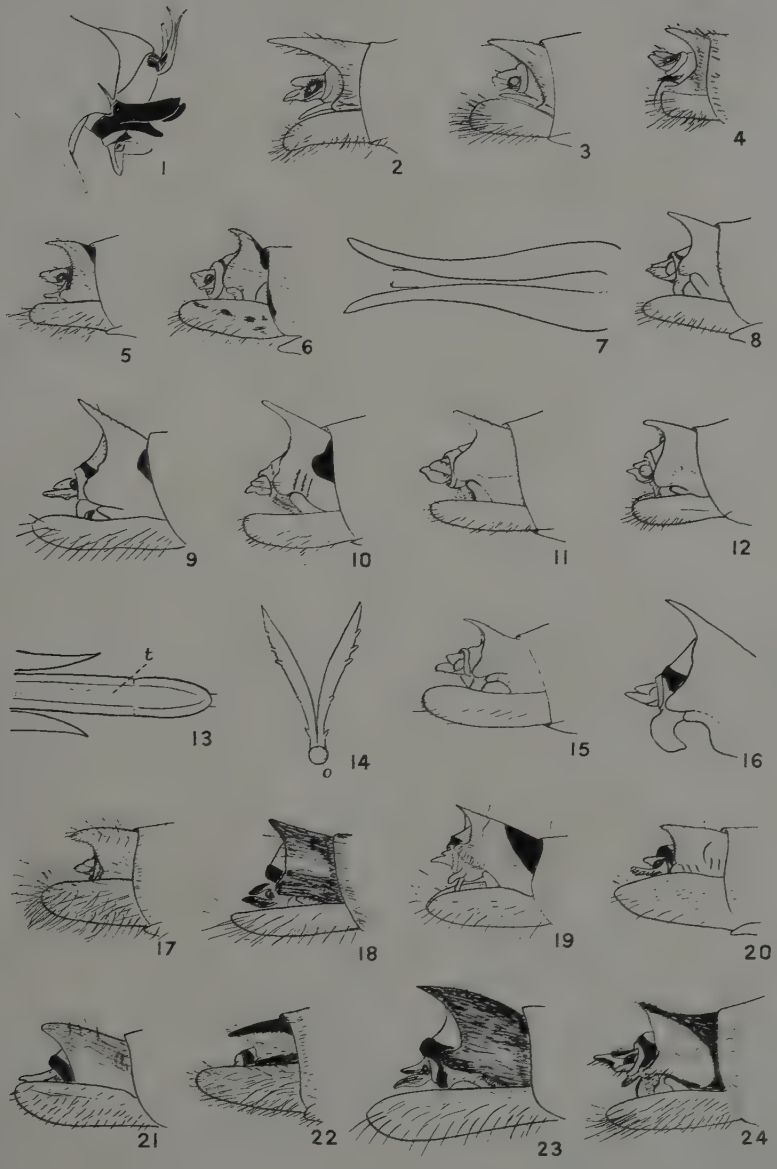
Fig. 1. *Melampsalta cingulata* (Fabr.), external view of exserted genitalia.
2. *M. cingulata*, ditto in normal position.
3. *M. strepitans* (Kirk.), do.
4. *M. sericea* (Walk.), do.
5. *M. cruentata* (Fabr.), do.
6. *M. leptomera*, Myers, do.
7. *M. leptomera*, apical portions of aedeagus.
8. *M. muta* (Fabr.), external view of genitalia.
9. *M. muta* var. *subalpina* (Huds.), do.
10. *M. muta* var. *cutora* (Walk.), do. (Kermadec specimen).
11. *M. ochrina* (Walk.), do.
12. *M. scutellaris* (Walk.), do.
13. *M. scutellaris*, dorsal view of tip of aedeagus, showing thin membranous central part of middle-piece (t).
14. *M. cauta*, Myers, ventral view of tip of aedeagus; *o* = opening.
15. *M. cauta*, external view of genitalia.
16. *M. cauta*, do. with hypandrium removed to show great development of Xth segment ventrally.
17. *M. nigra*, Myers (type), external view of genitalia.
18. *M. oromelaena*, Myers, do.
19. *M. iolanthe* (Huds.), do.
20. *M. campbelli*, Myers, do.
21. *M. hamiltoni*, Myers, do.
22. *M. lindsayi* (Myers), type, do.
23. *M. mangu*, F. B. White, do.
24. *M. cassiope* (Huds.), do.

Plate III.

Fig. 25. *M. cingulata*, aedeagus and copulatory hook.
26. *M. strepitans*, do.
27. *M. sericea*, Hawkes Bay form, do.
28. *M. cruentata*, do.
29. *M. sericea*, typical form, do.
30. *M. leptomera*, do.
31. *M. muta* var. *muta*, do.
32. *M. muta*, form intermediate between *muta* and *subalpina*, do.
33. *M. muta*, var. *cutora*, do.
34. *M. ochrina*, do.

Plate IV.

Fig. 35. *M. muta* var. *subalpina*, do.
36. *M. scutellaris*, do.
37. *M. cauta*, do.
38. *M. mangu*, do.
39. *M. oromelaena*, do.
40. *M. nigra*, do.
41. *M. lindsayi*, do.
42. *M. hamiltoni*, do.
43. *M. campbelli*, do.
44. *M. iolanthe*, do.
45. *M. cassiope*, do.



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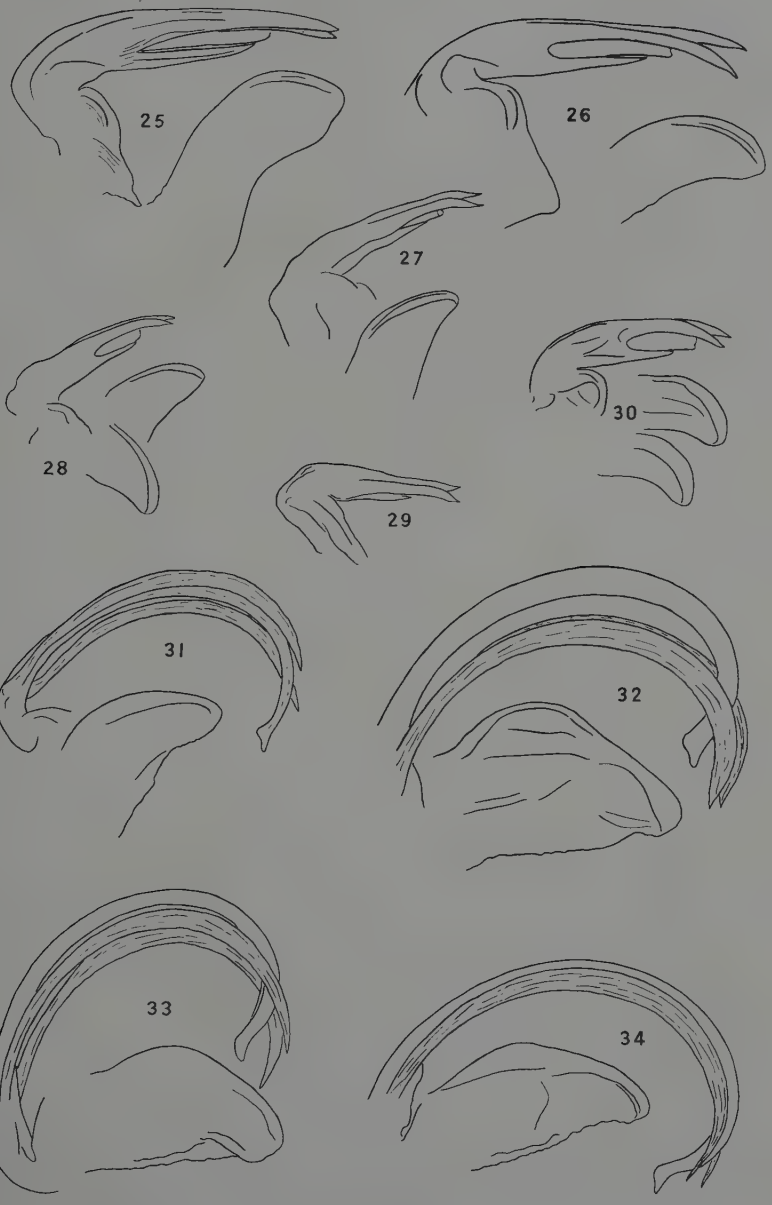

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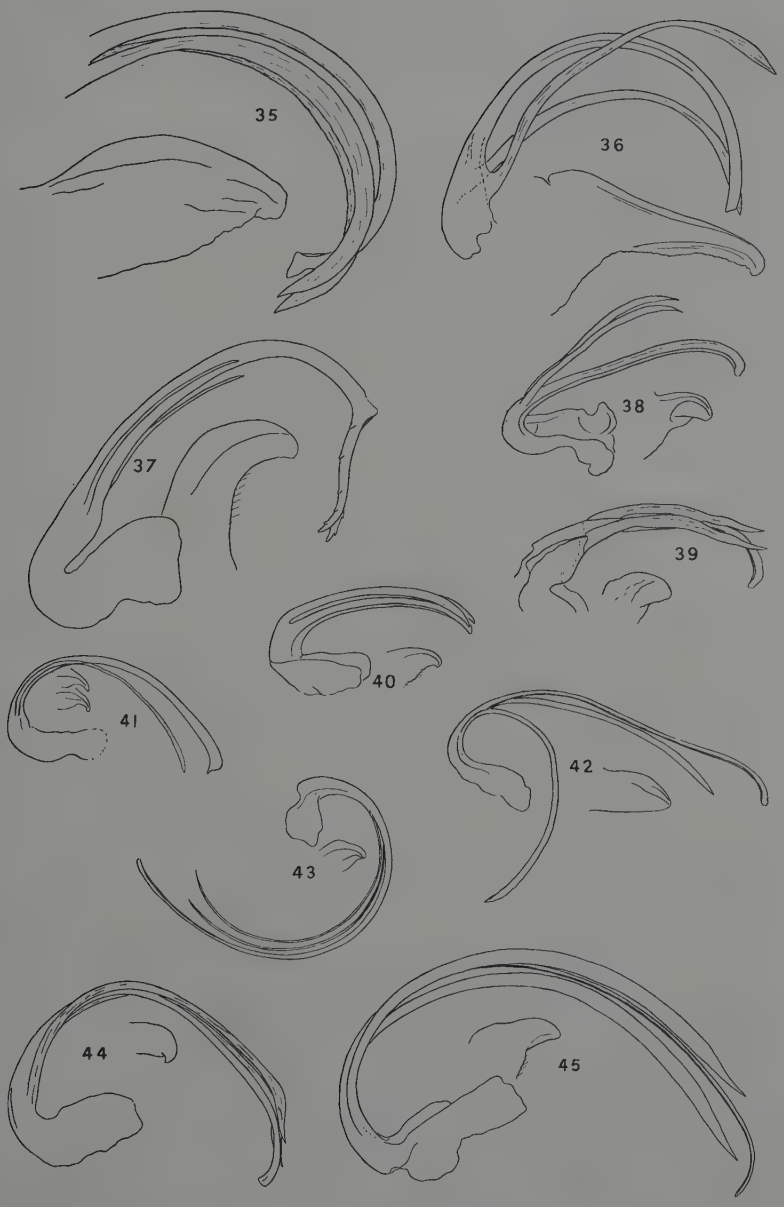

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GENITALIA OF THE NEW ZEALAND CICADAS.

ACRIDIDAE COLLECTED IN TANGANYIKA TERRITORY

By N. C. E. Miller.

[Read December 5th, 1928.]

Plates V–XI.

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I. Introduction.

The collections on which the present paper is based were made by the writer in the following districts, of which the soils and vegetation are briefly described. A short list of the species characteristic of these districts is also given :—

(1) Dar-es-Salaam (sea-level). The country to the west of the town is gently undulating and chiefly under cultivation, the principal plants grown being *Cocos nucifera*, L., *Mangifera indica*, L., *Musa* spp., *Manihot utilissima*, Pohl., and a small quantity of rice. The soil contains a large percentage of sand and coral, and is light greyish in colour. Water found in the low-lying areas is somewhat brackish. The most abundant species to be seen on areas which are more or less devoid of vegetation are *Acrotylus patruelis*, H. Sch., *Acrotylus junodi*, Schult., *Morphacris fasciata*, Thunbg., *Chrotogonus* spp., *Humbe tenuicornis*, Schaum; while in the bush areas where the grass is moderately tall, *Acrida sulphuripennis*, Gerst., *Cyrtacanthacris tatarica*, L., *Acanthacris lineata flava*, Sjöst., *Cataloipus oberthüri*, Bol., *Aiolopus longicornis*, Sjöst., *Bibulus brunni*, Gig. Tos., *Catantops sulphureus*, Walk., *Gastrimargus africanus*, Sauss., and *Paracinema tricolor*, Thunbg., are met with.

(2) Collecting in the Uluguru Mts. was carried out at an altitude of not more than 6000 ft. At this altitude, the mountain sides are mostly rather bare of trees and bushes, but are well covered with grass and low herbs. By the sides of the numerous mountain streams, however, the flora is very luxuriant. The rock formation is gneiss, and the soil contains a high percentage of mica particles. On the open parts of the mountains the species mostly met with are *Acrotylus patruelis*, H. Sch., *Morphacris fasciata*, Thunbg., *Ornithacris cyanea pictula*, Walk., *Acanthacris lineata flava*, Sjöst., *Aiolopus latus*, Uv., and *Anacridium moestum*, Serv., and, at lower altitudes, *Bibulus brunni*, Gig. Tos., *Catantops adustus*, Walk., and *Catantops sulphureus*, Walk. Near streams and in shady spots *Phymateus purpurascens*, Karsch, is found.

(3) The township of Kilosa (1624 ft.) is on the edge of an extensive plain, which reaches as far as the Uluguru Mts. to the south and south-east, and at the foot of a range of hills extending northwards. The plain, which is mostly under cultivation, with the exception of the part known as the Mkata Plain, is watered by the Mkondokwa and Myombo rivers. The principal food-plants cultivated here are millet, maize, *Manihot utilissima*, Pohl., and *Arachis hypogaea*, L. Some areas are planted with cotton. Small villages, built among groves of *Cocos nucifera*, L., and *Mangifera indica*, L., are scattered over the plain. The chief large trees in this area are *Kigelia africana*, Benth., *Sterculia appendiculata*,

K. Schaum., and *Tamarindus indica*, L. The hill country, which rises to about 3000 ft. is well covered with moderately thick bush composed of *Brachystegia* spp., *Diplorhynchus mossambicensis*, Benth., *Dalbergia melanoxylon*, Guill et Perr., *Dichrostachys nutans*, Benth., *Albizzia fastigiata*, E. Mey., *Dombeya* sp., *Combretum* spp., *Markhamia* sp., *Grewia* sp., and *Entada abyssinica*, Steud. The soil is red loam mixed with granitic sand.

(4) The country in the neighbourhood of Kipera, Uliya and Muhenda is chiefly of the dry forest type, and similar to the hill country round Kilosa as regards vegetation. Tindiga and Chilangali are on the edge of the Mkata Plain, which comprises a good deal of " mbuga " country, *i.e.* country which is always swampy during the rains and may be dry during the dry season. The Mkata Plain, which takes its name from the River Mkata which flows through part of it, is covered with tall grass for most of the year. There are, in parts, scattered clumps of bush, belts of dense bush composed of *Acacia* spp. and groves of *Borassus flabellifer*, L. The soil is mostly of the " black cotton " type. Kipera and Uliya are at mile 8½ and 20 on the Kilosa–Iringa road, Muhenda is at mile 30 on the Kilosa–Mahenge road.

In the bush country of these districts, the most abundant species are—*Acanthacris lineata flava*, Sjöst., *Acrida sulphuripennis*, St., *Aiolopus thalassinus*, F., *Bibulus crunni*, Gig. Tos., *Cataloipus oberthüri*, Bol., *Cyrtacanthacris tatarica*, L., *Cyrtacanthacris aeruginosa aeruginosa*, Stoll., *Catantops sulphureus*, Walk., *Catantops melanostictus*, Schaum., *Acorypha mossambicus*, Brancs., *Gastrimargus africanus*, Sauss., *Gastrimargus volkensi*, Sjöst., *Oxyrrhepes procera*, Burm., *Paracinema tricolor*, Thunbg., and *Zacompsa fallax*, Karny, and on bare ground, *Humbe tenuicornis*, Schaum., *Acrotylus patruelis*, H. Sch., *Morphacris fasciata*, Thunbg., and *Pycnodictya kilosana*, sp. n.

(5) The Ilundwe River lies some eight miles north of Kidode on the Kilosa–Mahenge road. Dense secondary forest with an undergrowth of *Acalypha* sp. and other shrubs covers its banks. A new species of *Eupropracris* was captured here.

(6) Kimamba on the Tanganyika Railway, between Morogoro and Kilosa is almost entirely under cultivation, sisal and cotton being the most important crops. The soil is of the " black cotton " type. In the plantations *Trilophidia* spp., *Acrotylus patruelis*, H. Sch., *Humbe tenuicornis*, Schaum., and *Morphacris fasciata*, Thunbg., were abundant.

(7) Mkidai, a small native settlement at kilom. 410 on the railway, lies in hilly country with a moderately dense bush composed of *Acacia arabica*, Willd., *Brachystegia* and *Berlinia*, spp. *Diplorhynchus mossambicencis*, Benth., *Combretum* spp., and *Strophanthus emini*, Aschers and Pax. The soil is composed of granitic sand and blackish earth. Not many grasshoppers were observed during a short stay here.

(8) The Dodoma district (3000 ft. approx.) is composed chiefly of dry thorn bush steppe in which the principal trees and shrubs are *Dichrostachys nutans*, Benth., *Strophanthus emini*, Aschers and Pax, *Acacia spirocarpa*, Hochst., and *Acacia glandulifera*, Schinz. During the dry season the sandy soil is almost bare of grass. A feature of this district are the rocky kopjes, among whose enormous boulders *Euphorbia nyikae*, Pax, *Grewia*, and other plants grow. The rainfall in this district is very low. Acridians to be found commonly in these areas are *Acrophymus cuspidatus*, Karsch, *Chrotogonus*, *Acorypha*, *Oedaleus plenus*, Walk., *Oedaleus senegalensis*, Krauss, and *Acrotylus*.

(9) Igkalula (Kalula), or Meta's, lies about forty miles south of Tabora. In this district a good deal of bush clearing has been carried out to allow for

the accommodation of natives evacuated from the areas further south where sleeping sickness is rife. The bush in this area is of the "dry forest" type, containing *Berlinia eminii*, Taub., *Brachystegia*, *Albizzia*, *Terminalia*, *Pterocarpus*, *Strychnos* and *Bauhinia*. The soil is mostly sandy except in "mbuga" areas, where it is black. The clearings and open spaces between belts of bush, during the time I was there, were teeming with grasshoppers of many species, both before and after the grass fires, which evidently do little damage to insect life. Kalula should not be confused with another place of the same name also in the Tabora district, but situated on the railway, a good many miles to the east of the township of Tabora. In the bush areas *Acrido-deres crassus aequalis* (n. subsp.) was captured, while, in the open areas, the following species were taken—*Ornithacris cyanea cyanea*, Stoll., *Ornithacris cyanea pictula*, Walk., *Acanthacris lineata flava*, Sjöst., *Acrida sulphuripennis*, St., *Acrida crocea*, Bol., *Acrotylus patruelis*, H. Sch., *Aulacobothrus werneriana*, Karny, *Anthermus* spp., *Bocagella lanuginosa*, Bol., *Cyrtacanthacris tatarica*, L., *Acorypha* spp., *Catantops sulfureus*, Walk., *Cannula linearis*, Sauss., *Cataloipidius roseus*, Bol., *Eupreprocnemis ibandana*, Gig. Tos., *Faurea milanjica*, Karsch (var. n. *coerulescens*), *Hemiacris* sp., *Heteropternis antennata*, Bol., *Ischnacrida monteiroi*, Bol., *Machaeridia bilineata*, Stål., *Oxya viridivitta*, Walk., *Parga xanthoptera*, Stål, ab. *rhodioptera*, Stål, *Rhamphacrida kraussi*, Bol., etc.

(10) The dominant bush in the Shinyanga sub-district is composed of various species of *Acacia*, e.g. *A. spirocarpa*, Hochst., in the more open areas, and *A. drepanolobium*, Engler, in the denser bush. In the neighbourhood of Kizumbi (3900 ft. approx.) the country is mostly open, large areas of bush having been cleared. The soil is a coarse granitic sand with patches of red or black earth in some areas. Rocky outcrops and large granite gneiss hills are frequently met with.

In the neighbourhood of Nyegezi (3900 ft. approx.) the country is more open, with short grass and scattered trees and bushes, including *Adansonia digitata*, L., *Acacia stuhlmanni*, Taub., *A. drepanolobium*, Engler, *A. spirocarpa*, Hochst., *Dichrostachys nutans*, Benth., and *Euphorbia tirucalli*, L., which grows chiefly round or in the vicinity of native villages and cattle enclosures. The soil is mostly black, intermixed with coarse granitic sand, and frequently broken up by outcrops of rock. Kitalala (3500 ft.) is situated near the junction of the Tungu and Manonga rivers and is in the midst of the "dry thorn bush" type of country. The principal trees are *Acacia drepanolobium*, Engler, *A. fistula*, Schweinf., *A. spirocarpa*, Hochst., *A. arabica*, Willd., *A. detinens*? Burch., and, near and along the two rivers, *A. arabica*, Willd., *Ficus*, *Borassus flabellifer*, L., and other plants which form dense thickets. The soil is black and is mixed with granitic sand. Open country with scattered low bushes is the prevailing type at Tinde and Bukene (4000 ft. approx.).

The grasshopper fauna of these areas of the Shinyanga sub-district is similar to that of the Dodoma and Tabora districts.

(11) Korogwe (2000 ft.) is on the Tanga–Moshi Railway and the Pangani river. To the south, the country is rather flat with large areas of grazing land and cultivated land on which the principal crop is sisal. There are also extensive rubber plantations, which, after not having been exploited for many years, have degenerated into dense thickets. To the north are the Usambara Hills. The most abundant species in this district were—*Cataloipus oberthüri*, Bol., *Catantops melanostictus*, Schaum., *Comacris semicarinata*, Gerst., *Morphacris fasciata*, Thunbg., and *Tylotropidius gracilipes*, Brancs.

(12) Muheza, on the Tanga-Moshi Railway, is in undulating and hilly

country mostly under cultivation. Sisal, maize and millet are the principal crops. The soil is red loam. A small collection comprising *Acrida sulphuripennis*, St., *Aiolopus thalassinus*, F., *Acrotylus patruelis*, H. Sch., *Duronia chloronota*, St., and *Morphacris fasciata*, Thunbg., was made here.

(13) The Usambara Hills in the Mhindulo and Segoma districts are covered mostly with temperate rain forest composed of *Khaya*, *Chlorophora excelsa*, Welw., and other large trees. Undergrowth in the forest consists mostly of *Grewia*, *Acalypha*, and liliaceous plants. The lower parts of the hills and valleys are well clothed with thick *Grewia* bush, tall trees and occasional bamboo thickets. The rubber plantations here, as elsewhere, are completely overgrown. In the forest, *Eupropacris cylindricollis*, Schaum, and *Parapetasia impotens*, Karsch, were found. In the lower areas, *e.g.* near the Zigi and Msimbazi rivers, I found *Ixalidium obscuripes*, n. sp., *Euschmidtia zanzibarica*, Karsch, *Metapa usambarica*, Karsch, and *Atractomorpha gerstaeckeri*, Bol.

The grasshoppers mentioned in this paper as having been taken at Mkalama, Kondoa-Irangi, Tubugwe and Mtugutu were collected by a native. Having never visited these districts myself, I refrain from giving a description of the types of country, knowing them only from reports.

In addition to the species enumerated and described herein, a considerable number of single specimens of species which are possibly new were captured. These have been put aside until more material may be obtained.

I am greatly indebted to Mr. B. P. Uvarov of the Imperial Bureau of Entomology for assistance and advice which were at all times freely given. My thanks are also due to Dr. W. Ramme of the Berlin Museum for sending the types of certain species for comparison, to Prof. Sjöstedt for supplying the identifications of some species of *Gastrimargus*, and to the authorities of the British Museum (Natural History) for permission to work there.

The types of all new species are in the British Museum (Natural History).

II. List of the Species Obtained.

Tetriginae.

Paratettix scaber, Thunbg.

Pneumorinae.

Shortridgea absidata, Karsch.

Eumastacinae.

Plagiotriptus hippiscus, Gerst.
Euschmidtia zanzibarica, Karsch.

Acridinae.

Acrida crocea, Bol.
„ *sulphuripennis*, Gerst.
Acridella rendalli, Kirby.
Cannula linearis, Sauss.
Parga xanthoptera, Stål, ab. *rhodioptera*, Stål.
Sumba nigrescens, sp. n.
Panzia uvarovi, gen. nov. et sp. n.
Machaeridia bilineata, St.
Duronia chloronota, St.
Comacris semicarinata, Gerst.
Orthochtha dimorpha, sp. n.
Zacompsa brevipennis, sp. n.
Zacompsa temporalis, Stål.
„ *fallax*, Karny.
Gymnobothrus subparallelus, Rehn.
Paracinema tricolor, Thünbg.
Stenohippus spp.
Pnorisa squalus, St.
Faurea milanjica, Karsch, var. **coerulescens,** var. n.
Prostethophyma cephalica, Bol.
Aulacobothrus brevipennis, sp. n.
„ **subsinuatus,** sp. n.
„ *werneriana*, Karny.
Berengueria rotundifrons, Bol.
Aiolopus thalassinus, F.
„ *longicornis*, Sjöst.

Oedipodinae.

Humbe tenuicornis, Schaum.
Morphacris fasciata, Thunbg.
„ „ „ ab. *aurantiaca*, Uv.

Heteropternis antennata, Bol.
„ *saussurei*, Kirby.
Pycnodictya thalassina, Kirby.
Pycnodictya kilosana, sp. n.
Oedaleus senegalensis, Krauss.
„ *plenus*, Walk.
Oedaleus dilutus, sp. n.
Gastrimargus africanus, Sauss.
„ *volkensi*, Sjöst.
„ *longipes*, Sjöst.
Locusta migratoria, L.
Trilophidia spp.
Tmetonota dispar, sp. n.
Acrotylus patruelis, H. Sch.
„ *junodi*, Schult.
„ „ „ **rubescens**, ab. n.
„ *angulatus*, Stål.
„ *hyalinus*, Bol.
Conipoda gracilis, sp. n.

PYRGOMORPHINAE.

Chrotogonus rotundatus, Kirby.
„ *rendalli*, Kirby.
Maura modesta, Bol.
Petasia fuscorosea, Sjöst.
Parapetasia impotens, Karsch.
Phymateus aegrotus, Gerst.
„ *purpurascens*, Karsch.
„ *viridipes*, Stål.
Tanita dispar, sp. n.
Atractomorpha gerstaeckeri, Bol.

PAMPHAGINAE.

Lamarckiana kilosana, sp. n.
Lamarckiana loboscelis, Schaum.
„ spp.

CATANTOPINAE.

Ixalidium obscuripes, sp. n.
Oxya viridivitta, Walk.
Spathosternum pedestris, sp. n.
Tristria brunneri, Karsch.
„ *sudanensis*, Karny.
„ *coerulipes*, Uv.
Oxyrrhepes procera, Burm.
Anoxyrrhepes natalensis, Uv.
Homoxyrrhepes punctipennis, Walk.
Metapa usambarica, Karsch.
Ischnacrida monteiroi, Bol.
Rhamphacrida kraussi, Bol.
Acanthoxia gladiator, Westw.
Mesopsis laticornis, Krauss.
Anthermus sp.
Anthermus acutifrons, sp. n.
Anacridium moestum, Serv.
Cyrtacanthacris aeruginosa, Stoll.
„ „ **submaculata**, subsp. n.
„ *tatarica*, L.
Ornithacris cyanea cyanea, Stoll.
„ „ *magnifica*, Bol.
„ „ *pictula*, Walk.
Kraussaria dius, Karsch.
Rhytidacris punctata, Kirby.
„ *tectifera*, Karsch.
Nomadacris septemfasciata, Serv. ph. *coangustata*, Luc.
Acanthacris lineata flava, Sjöst.
Acridoderes crassus, Bol., **aequalis**, subsp. n.
Hemiacris spp.
Abisares viridipennis, Burm.
Bocagella lanuginosa, I. Bol.
Parepistaurus deses, Karsch.
Eupropracris cylindricollis, Schaum.
Eupropracris abbreviata, sp. n.
„ **obscura**, sp. n.
Catantops decipiens, Karsch.
„ *minimus*, Karny.
„ *brunneri*, Karny.
„ *melanostictus*, Schaum.
„ *sulphureus*, Walk.
„ *adustus*, Walk.
Catantops hemipterus, sp. n.
„ **curvicercus**, sp. n.
„ **viridipunctatus**, sp. n.
„ **hirtus**, sp. n.
Cardenius formosus, sp. n.
„ **nigripes**, sp. n.
Stenocrobylus crassus, sp. n.
Acorypha pallidicornis, Stål.
„ *mossambicus*, Brancs.
Acrophymus cuspidatus, Karsch.
Oxyaeida brachyptera, sp. n.
Bibulus brunni, Gig. Tos.
Tylotropidius speciosus, Walk.
„ *gracilipes*, Brancs.
„ sp.
Cataloipus oberthüri, Bol.
Cataloipidius roseus, Bol.
Thisoicetrus coerulipes, Sjöst.
Eupreprocnemis ibandana, Gig. Tos.
Eupreprocnemis capitatus, sp. n.

III. Systematic Account of the Species.

Subfam. Tetriginae.

Paratettix scaber, Thunbg.

Kilosa, Tindiga. On bare ground.

Subfam. Pneumorinae.

Shortridgea absidata, Karsch.

One ♂: Muhenda, 10.iv.26. One ♂: Kilosa, April 1927.

Both these were taken at light, the first at a camp fire, and the second attracted to a paraffin lamp in a house. This species is apparently abundant, but rarely seen owing to its arboreal habits. I was informed by the late Lt.-Col. Fair, D.S.O., of the Game Department, Tanganyika Territory, that large numbers of this handsome Acridian were attracted to his camp fire in a camp at Myombo seven miles from Kilosa, on the Kilosa–Iringa Road.

Stridulation was frequently heard at about an hour before daybreak, *i.e.* 4.30 a.m. to 5 a.m., and consisted of a series of bell-like notes repeated six or seven times.

Subfam. Eumastacinae.

Plagiotriptus hippiscus, Gerst. (Plate VI, fig. 11.)

Dar-es-Salaam; Tindiga; Chilangali; Kilosa.

Euschmidtia zanzibarica, Karsch.

One ♀: Msimbazi R.

This specimen agrees with the specimen in the B.M. except that it is slightly larger and the elytra are longer. The measurements are given for comparison:—

	Total length. mm.	Elytra. mm.	Posterior femora. mm.	Pronotum. mm.
Msimbazi R. specimen .	25	6·5	14	4
B.M. specimen . .	21·5	3·5	13·5	3

The coloration of the living insect is as follows :—

Antennae brownish orange. Eyes greenish with a purplish metallic lustre. Face and genae greenish yellow; genae with an irregular crimson stripe extending from the lower anterior margin of the eye, almost to the lower posterior margin. Occiput dull greenish purple; fastigium green. Pronotum and elytra greenish purple; anterior area of lateral lobes yellow; posterior area light green with the inferior margin crimson; meso-sternal episternum and epimeron greenish yellow, suffused with purple basally; meta-sternal episternum greenish yellow suffused for the most part with purple; anterior third of meta-sternal epimeron yellow, median third light green, basal third purple. Sternites and ventral parts of abdomen greyish purple. Abdomen dorsally greenish purple with yellowish-green blotches on the sides of the first to fifth basal segments; sixth and seventh segments with an irregular black marking laterally. Cerci blackish. Ovipositor valves dark green with the serrations black. Anterior and median legs green; femora of posterior legs green with the genicular arches and apices black; posterior tibiae pale crimson. Spines black; posterior tarsi pale crimson with the apex of each segment black and greenish. Wings infumate.

Subfam. Acridinae.

Acrida crocea, Bol.

One ♂, two ♀'s : Kalula.

Acrida sulphuripennis, Gerst.

A very abundant species in open country grassland and bush. Taken at Dar-es-Salaam; Muheza; Kilosa; Chilangali; Mhindulo; Msimbazi River; Uluguru Mts.; Kalula; Nyegezi; Mlemu; Kissaki; Kitope.

Acridella rendalli, Kirby.

Three ♀'s : Kizumbi; Kilosa; Nzuki.

Cannula linearis, Sauss.

One ♂ and one ♀ : Tubugwe. One ♀ : Kilosa.

Parga xanthoptera, Stål, ab. *rhodioptera*, Stål.

One ♀ : Kalula.

Sumba nigrescens, sp. n. (Plate VIII, figs. 17 and 18.)

Antennae light brown, darker basally; eyes pale amber; face yellowish black; clypeus reddish yellow; remainder of head black; pronotum and pleurae black; sternites and abdomen yellowish brown; anterior and median legs brownish; exterior faces of posterior femora light brown; knees and superior interior and exterior faces of posterior femora black; internal and exterior inferior faces reddish; posterior tibiae pale greyish green with the condyle blackish; spines on posterior tibiae broadly tipped with black; elytra blackish, darker basally; wings faintly infumate, very faintly bluish basally and more darkly infumate in the apical area.

Antennae longer than the head and pronotum together by about a quarter of their length, moderately compressed for about half their basal length; eyes pyriform, moderately oblique; interocular distance equal to about two-thirds greatest fastigial width; fastigium from above ovate, with the apex narrowly rounded and the lateral margins feebly angulate, and with a median longitudinal carina which extends backwards along the occiput; frontal ridge sulcate, with the margins constricted slightly above and below median ocellus, feebly sinuate and divergent near the clypeus; lateral facial carinae feebly sinuate; in profile, frontal ridge almost straight; surface of face and occiput rugulose; of genae, almost smooth; anterior margin of pronotal disc feebly rounded; posterior margin broadly rounded; anterior margins of lateral lobes almost straight; posterior and inferior margins sinuate; lateral carinae of disc feebly sinuate, subparallel; second and third transverse sulci distinct on disc only; disc feebly tectiform; surface of disc rugulose; of lateral lobes and pleurae very feebly rugulose punctate.

Supra-anal plate (♂) ovate, laterally basally compressed with a median basal depression; subgenital plate (♂) conical, narrowly rounded apically.

The ♀ paratype has a striking creamy band along the head, pronotum and anal field of elytra. The species differs from *Sumba roseipennis*, Bol., by the colour of the wings, the sculpture of the head and pronotum, the margins of the frontal ridge, which are more sinuate, and by its slightly larger size.

Described from two ♂'s and one ♀ : Kalula. Type ♂.

Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂ 15	3	12·5	9
♀ 17	3	14	10

Panzia, gen. nov. (Plate V, fig. 2; Plate IX, figs. 39 and 40.)

Size moderate; antennae compressed and dilated basally; face strongly oblique; frontal ridge in profile projecting between antennae; fastigium of the vertex strongly projecting forward, oval; margins feebly raised; eyes oval, oblique; interocular distance slightly less than greatest fastigial width; pronotum, with no foveolae, compressed laterally; disc almost flat; median carina straight, intersected by third sulcus just past the centre; lateral carinae irregular, particularly in prozona; lateral lobes higher than long; elytra narrowly rounded apically, with the costal lobe moderately well developed; scapular area irregularly reticulate; cross veinlets in the basal half very dense and irregular; wings with the outer margin of each lobe rounded; cross veins regularly disposed, those in the outer part incrassate; posterior femora not reaching to the apex of the elytra.

Panzia uvarovi, sp. n.

♂ Type. Surface of head and pronotum strongly rugulose tuberculate; basal segment of antennae large, ovate, second segment small, cylindrical, third to the tenth segments compressed dorso-ventrally, the third to the sixth being about twice as broad as the seventh to the tenth segments; remainder filiform, moderately thick; margins of frontal ridge irregularly sinuate, obsolescent towards clypeus; fastigium oval, the lateral margins convergent behind, but not reaching the median carinula; anterior margin of pronotal disc feebly rounded; posterior margin rotundato-angulate; anterior and posterior margins of lateral lobes almost straight and irregularly thickened; inferior margins bisinuate; median carina of disc straight and deeply intersected by the third sulcus; lateral carinae well developed, sinuate; surface of pronotum rugulose tuberculate; cerci simple; elytra exceeding the apex of the posterior femora by about an eighth of their total length; oblique ridges on external face of posterior femora sublaminate; supra-anal plate triangular, with the apex narrowly rounded, three times as long as broad, strongly laterally compressed and with a broad median longitudinal sulcus.

♀ Paratype. Antennae slightly longer than the head and pronotum together; margins of fastigium feebly angulate; posterior margin of pronotal disc more obtuse angulate than in the ♂ type; anterior and posterior margins of lateral lobes feebly sinuate; elytra exceeding the apex of the posterior femora by about a twelfth of their total length; supra-anal plate triangular, with the apex moderately rounded; laterally compressed and with a broad impression basally.

This new genus differs from *Sumba*, Bol., by being larger and more robust, by the antennae, which are considerably broader in the basal half, by the shape of the lateral margins of the vertex, which are rounded and not angulate, and by the surface of the head and pronotum which are rugulose tuberculate, not rugulose only. The wings are more ample and the outer margin of each lobe is more rounded; general coloration light reddish brown; eyes light brown; wings lemon yellow with the outer area infumate.

The name which has been allotted to this genus is derived from *Panzi*, the KiSwahili for grasshopper.

Described from one ♂ (type) and two ♀'s: Kalula.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	19	3·5	16	11
♀	21	4	17	11

Machaeridia bilineata, St.

One ♂: Kalula. Seven ♀'s from: Kalula (2), Kilosa (2), Uluguru Mts. (2), Chilangali (1).

Duronia chloronota, St.

A large series from the following localities:—Tindiga; Kilosa; Chilangali; Bukene; Muheza.

Comacris semicarinata, Gerst.

Korogwe; Myombo; Chilangali.

Larger than the specimens from Zanzibar and Dar-es-Salaam in the B.M. The colour of the wings is deep orange in the basal area in those taken at Korogwe, and a pale smoky yellow in the Myombo and Chilangali examples.

Orthochtha dimorpha, sp. n. (Plate VIII, fig. 30; Plate X, figs. 50, 51, 52, 53.)

Eyes light amber; antennae black; face and genae yellowish green; genae with a blackish stripe along superior margin; occiput and pronotal disc pinkish grey; lateral lobes yellowish green, with a blackish stripe along superior margin; pleurae, anterior and median legs and femora of posterior legs yellowish green; posterior tibiae crimson; costal portion of mediastinal area of elytra grass green; inner area pale bluish white bordered with blackish; remainder of elytra hyaline with pinkish-brown nervures and reticulation; wings very pale lemon yellow; abdomen light yellowish brown, somewhat darker dorsally.

The ♀ differs from the ♂ in having the antennae crimson, the occiput yellowish green, the disc of the pronotum lighter in coloration and suffused with yellowish green, and the colour of the elytra much darker, the pale bluish-white stripe being absent. The sides of the abdomen are greenish yellow towards the apex.

Antennae slender, rather strongly compressed dorso-ventrally in the basal third; in the ♂ almost twice as long as head and pronotum; in the ♀ longer than head and pronotum by about a quarter of their length; eyes elongate ovate, with the front margin slightly longer than the hind margin; interocular distance slightly less than greatest fastigial width; fastigio-facial angle narrowly rounded (♂), or more broadly rounded (♀); fastigium from above narrowly rounded apically (♂), or more broadly rounded (♀); lateral margins feebly concave; surface deeply impressed; in the ♀ there is a median longitudinal carinula; occiput very feebly rounded (♂), or almost straight (♀); frontal ridge in profile almost straight with a feeble concavity at the median ocellus; from the front, margins parallel to slightly below median ocellus, then divergent; sulcate; lateral facial carinae straight (♂), or feebly arcuate (♀); surface of head smooth with scattered punctures on the face and irregular depressions on the inferior area of the genae; median carinae of pronotum in profile almost straight; anterior margin of disc almost straight; posterior margin feebly rounded; median carina distinct; lateral carinae distinct and irregularly thickened; transverse sulci indistinct on disc, distinct on lateral lobes; anterior margins of lateral lobes almost straight; posterior margin concave; inferior margins sinuate; surface of pronotum rugulose punctate, more strongly so on metazona and anterior area of prozona; surface of pleurae rugulose punctate, more strongly so in the ♀.

Supra-anal plate (♂) triangular, narrowly rounded apically, laterally compressed and depressed medially basally; subgenital plate (♂) broadly conical with the apex narrowly rounded; surface punctate; supra-anal plate (♀) triangular with the apex narrowly rounded, the sides somewhat concave, laterally basally compressed and with a strong median longitudinal sulcus; subgenital plate (♀) quadrate, with a median apical projection, which is rounded apically and a broad but rather feeble depression in the apical third; cerci (♂) long, slightly compressed, slightly exceeding the apex of the subgenital plate;

elytra (♂) almost reaching the apex of the posterior femora, narrowly rounded apically; elytra (♀) reaching the apex of the first abdominal segment; very narrowly rounded apically.

Described from two ♂'s (including type) and one ♀: Tindiga.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.	Antennae. mm.
♂	37	6	27	22	20
♀	40	7	12	22	14

Zacompsa brevipennis, sp. n. (Plate IX, fig. 42.)

Coloration variable: unicolorous brown, light brown or ashy brown with a very pale stramineous spot on the inferior half of the lateral lobes; antennae light brown basally, dark brown for the remainder; superior half of lateral lobes blackish brown; abdomen light brown; posterior femora reddish brown, pale reddish below, with black spots on the carinae and oblique ridges; knees black, with two irregular blackish fasciae on the superior exterior face; posterior tibiae black basally, blackish for the remainder with a narrow whitish fascia next the black basal portion; anterior and median legs light brown, with darker brown fasciae; elytra light brown, slightly iridescent, with black maculation in the basal half; wings infumate, paler basally.

Antennae filiform, (♂) one and a half times, (♀) very slightly longer than head and pronotum together; eyes broadly oval; interocular distance equal to twice the width of the frontal ridge between antennae; frontal ridge from the front sulcate throughout, more deeply impressed round ocellus; margins constricted above ocellus and widening below; surface strongly punctate; in profile almost straight; fastigium from above truncate apically, lateral margins obtuse angulate with the anterior half feebly concave; surface impressed; surface of head smooth with scattered punctures; occiput somewhat rugulose; genae with a diagonal sulcus behind and below the eyes; anterior margin of pronotal disc narrowly rotundato-angulate; posterior margin broadly rotundato-angulate; anterior margins of lateral lobes feebly sinuate; posterior margins almost straight; inferior margins obtuse angulate, with the anterior half feebly concave and the posterior half almost straight; pronotum strongly laterally compressed in the superior area of the prozona; lateral carinae of disc distinct and arcuate, sometimes obliterate; surface of pronotum and pleurae rugulose punctate; cerci ♂ simple, hirsute.

Supra-anal plate (♂) triangular, about as broad as long, laterally basally compressed and very deeply and broadly impressed; subgenital plate (♂) conical, with the apex narrowly rounded, and somewhat recurved; supra-anal plate (♀) pentagonal with the apex and apical half of sides narrowly rounded; laterally basally compressed; surface irregularly impressed and punctate; subgenital plate (♀) quadrate, with a median apical projection; elytra rather narrow, just exceeding the apex of the posterior femora in length; oblique ridges on posterior femora distinct, sublaminate.

Very similar to *Z. temporalis*, St., but smaller and with distinctly shorter elytra.

Described from specimens collected in Kilosa, Kissaki, Msimbazi R., Tubugwe, Muheza, Chilangali, Myombo, Mhindulo, Uluguru Mts., Bukene. Type ♂ from Kilosa.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	16	3	13	10
♀	21·5	4	18	13

Zacompsa temporalis, Stål.

Bukene; Uluguru Mts.; Tubugwe (Dodoma dist.); Myombo; Kalula; Kissaki; Kilosa; Chilangali.

Zacompsa fallax, Karny.

Kilosa; Kimamba; Tubugwe (Dodoma dist.); Msimbazi R.; Kissaki.

Gymnobothrus subparallelus, Rehn.

Bukene; Kilosa.

Paracinema tricolor, Thunbg.

Kilosa; Tubugwe; Myombo; Chilangali.

Stenohippus spp.

Three species. One ♂, Bukene; one ♀, Nyegezi; one ♂, Kalula.

Pnorisa squalus, St.

Bukene; Tubugwe; Kalula; Kilosa; Chilangali; Myombo.

Faurea milanjica, Karsch, var. **coerulescens**, n.

Differs from *Faurea milanjica*, Karsch, in the following respects:—More robust. The pronotum is longer, the posterior femora are without black spots and the wings are either pale blue or pale yellow basally.

A short series from the following localities:—Kilosa; Uluguru Mts.; Kalula (the type).

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	19	4	17	12
♀	25	5	23	15

Prostethophyma cephalica, Bol.

Uliya: One ♂ and one ♀ *in cop.*

Aulacobothrus brevipennis, sp. n. (Plate X, figs. 54, 55.)

Antennae stramineous basally, brownish for remainder of length; eyes light amber with irregular brown maculation; face stramineous with a fine blackish maculation which is more pronounced on frontal ridge; temporal foveolae blackish; inferior area of genae and occiput pale stramineous; superior areas of genae darker stramineous; genae with a narrow cream-coloured stripe bordered with a fine brown maculation extending from near the base of the eye; median carina of pronotum and inferior margins of lateral lobes pale stramineous; lateral lobes with irregular pinkish-brown shading, darkest in the inferior median area; pleurae stramineous with brownish shading on inferior area of meso-thoracic episternum and most of the meso-thoracic epimeron; sternites and abdomen brownish yellow. Antennae filiform, feebly compressed, equal to elytra in length; eyes pyriform with the front margin almost straight; face reclinate; frontal ridge broad, sulcate throughout, strongly punctured, margins parallel but widening near clypeal suture; in profile, almost straight; interocular distance slightly less than greatest fastigial width; occiput in profile feebly rounded; vertex subhorizontal, transverse; surface of face feebly rugose; of genae smooth, except for the inferior posterior area which is feebly foveolate; surface of occiput feebly foveolate; foveolae of the vertex moderately impressed, broad; median carina of pronotum in profile straight; anterior margin of disc rounded; posterior margin broadly rotundato-angulate; anterior margins of lateral lobes almost straight; posterior

margins sinuate; inferior margins broadly obtuse angulate with the anterior half slightly concave, and the posterior half feebly sinuate; median carina of disc smooth, cut by the hind sulcus; lateral carinae straight, foveolate and present only on pro- and meso-zona; surface of pro- and meso-zona rugose; of metazona feebly punctate and rugulose; lateral lobes depressed medially basally; first and second sulci distinct, cutting lateral carinae but not reaching median carina; pleurae strongly rugulose and very sparsely hirsute; elytra extending to nearly half the length of the posterior femora, rather narrow, with the apices narrowly rounded; posterior tibiae with the inner spurs longer than the outer ones; inner spurs regularly but feebly curved, the lower one being slightly longer than the upper one.

Described from one ♀: Chilangali.

Total length.	Pronotum.	Elytra.	Posterior femora.
mm.	mm.	mm.	mm.
23·5	4·75	7	12

Aulacobothrus subsinuatus, sp. n. (Plate IX, fig. 44.)

Antennae light brown; eyes brownish stramineous; head and body stramineous; sides of occiput and pronotal disc brownish; posterior tibiae, basal third whitish, remainder red; posterior femora pale stramineous with the knees brownish and the inferior internal face orange; spines on posterior tibiae broadly tipped with black; elytra with a faint metallic sheen, smoky apically and with a few brownish spots; wings pale blue, slightly infumate apically.

Antennae filiform and finely punctate; distinctly longer than the head and pronotum together; eyes pyriform with the front margin almost straight; face moderately oblique; in profile, frontal ridge feebly rounded; from the front, margins parallel, but narrowing slightly above median ocellus; surface foveolate; lateral facial carinae distinct and arcuate; occiput in profile very feebly rounded; from above, with a median longitudinal carinula and with the surface on each side of the carinula strongly foveolate; fastigium of the vertex pyriform, deeply and irregularly impressed, with a median carinula which extends to the occiput, and is more distinct in the ♀; interocular distance equal to greatest fastigial width; median carina of pronotum in profile almost straight; lateral carinae distinct and somewhat arcuate in the ♂, but less distinct in the ♀; anterior margin of disc of pronotum almost straight; posterior margin rectangular, with the angle rounded and the sides very feebly concave; anterior margins of lateral lobes straight; posterior margins feebly sinuate; inferior margins rotundato-angulate with the anterior half feebly concave; surface of disc rugulose punctate, more strongly so in the metazona; surface of lateral lobes irregularly foveolate, with the foveoles larger and more deeply impressed on the superior anterior area; surface of pleurae rugulose punctate with a distinct median carina on the meta-thoracic episternum.

Elytra with the cross-venation in the apical half of the mediastinal area regular and widely separated; in the apical half of the discoidal area, widely separated. Spurs on posterior tibiae regularly but feebly curved; feebly bristly; posterior femora nearly reaching apex of elytra; oblique ridges distinct, sublaminate; supra-anal plate (♂) tri-angular, with the apex rounded, compressed basally laterally and with a median basal depression; subgenital plate (♂), conical, with depressions basally laterally; surface punctate and feebly hirsute; subgenital plate (♀) quadrate, with the apical margin obtuse angulate, and the sides feebly concave.

Described from two ♂'s (including the type) and one ♀: Kalula.

	Total length.	Pronotum.	Elytra.	Posterior femora.
	mm.	mm.	mm.	mm.
♂	19	4	16	12·5
♀	23	5	19	15

Aulacobothrus wernerianus, Karny.

Kalula.

Berengueria rotundifrons, Bol.

Two ♂'s, four ♀'s: Kalula. One ♂: Tubugwe.

Aiolopus thalassinus, F.

Kilosa; Kissaki; Muheza, Korogwe; Uluguru Mts.; Kalula; Myombo; Tubugwe; Nyegezi; Chilangali.

Aiolopus longicornis, Sjöst.

Dar-es-Salaam; Kissaki; Kimamba; Tindiga; Kilosa; Shinyanga.

Subfam. Oedipodinae.

Humbe tenuicornis, Schaum.

Kilosa; Tubugwe; Myombo; Uluguru Mts.; Dar-es-Salaam; Mtugutu; Kitope; Kissaki; Chilangali; Bukene; Muheza; Mhindulo. A very abundant species in all the localities mentioned.

Morphacris fasciata, Thunbg.

An abundant species found almost exclusively on bare ground. One ab. *aurantiaca*, Uv., was taken at Kissaki, 28.iii.27.

Other localities in which this species was captured are Kilosa; Myombo; Kissaki; Muheza; Dar-es-Salaam; Korogwe; Mhindulo; Tindiga; Chilangali; Bukene.

Heteropternis antennata, Bol.

Kilosa; Kalula; Bukene.

Heteropternis saussurei, Kirby.

Uluguru Mts.; Kilosa.

Pycnodictya thalassina, Kirby ?

One ♀: Kilosa. One ♂: Uluguru Mts.

The black band on the wings is almost interrupted, and narrower than in the type.

Pycnodictya kilosana, sp. n. (Plate V, fig. 6; Plate VII, fig. 15.)

General coloration light reddish or greyish brown, with darker brown or blackish markings; elytra with two broad transverse brownish or blackish fasciae, which are very pronounced in some examples; wings pale magenta red with a moderately broad smoky transverse fascia which is narrowly interrupted at vena dividens; outer area hyaline or very faintly infumate, more so in the ♂; posterior femora (♂) light reddish or greyish brown, with three broad blackish transverse fasciae and blackish spots on the inferior carina; knees blackish; tibiae light brown, spines tipped with black; posterior femora (♀) light greyish brown with a blackish suffusion on the external face in the apical half; posterior tibiae as in the ♂.

Antennae filiform, about a sixth longer than head and pronotum together; eyes oval with the front margin almost straight; interocular distance slightly greater than width of frontal ridge between antennae; fastigium from above rotundato-truncate apically; lateral margins convex; surface impressed and feebly rugose; frontal ridge in profile

almost straight; from the front, margins irregularly sinuate and obsolescent near clypeus; surface irregularly impressed and strongly punctate; surface of head smooth, except inferior area of genae which is punctate; anterior margin of pronotal disc broadly obtuse angulate; posterior margin acute angulate in the ♂, forming an angle of about 90° in the ♀; anterior margins of lateral lobes strongly sinuate and irregularly thickened; inferior margins sinuate; posterior margins very feebly sinuate; median carina of disc distinct, irregularly thickened and intersected by the third sulcus only; surface of disc rugose, with some tubercles near posterior margin of metazona; surface of lateral lobes rugulose punctate; there is an almost smooth area in the centre of the prozona; surface of pleurae rugulose punctate; supra-anal plate (♂) triangular, rather broadly rounded apically, with a median basal sulcus and with the apical half dorso-ventrally compressed; subgenital plate (♂) conical, hirsute; supra-anal plate (♀) triangular, about as broad as long, broadly rounded apically; subgenital plate (♂) quadrate, broadly rounded apically; cerci (♂) simple; posterior femora reaching to the apex of the abdomen; elytra rotundato-truncate apically; costal lobe moderately well developed.

Described from three ♂'s and seven ♀'s (including the type): Kilosa. One ♀: Kissaki.

	Total length.	Pronotum.	Elytra.	Posterior femora.
	mm.	mm.	mm.	mm.
♂	22	6	23	13
♀	32	7	27	16

Oedaleus senegalensis, Krauss.

Large swarms were observed in the Dodoma district in March 1927. It is not known whether any damage was done by them to crops. A fairly large series of males and females was taken at Mlemu, about fifteen miles north of Dodoma.

This species has been also recorded from Senegal, Sudan, Mesopotamia, Persia and the Punjab.

Oedaleus plenus, Walk.

Tindiga; Kitope. One ♂ and one ♀.

Other localities from which this species is recorded are:—Cape Province, Orange Free State, Transvaal and S. Rhodesia.

Oedaleus dilutus, sp. n. (Plate IX, fig. 33.)

♂. Antennae brownish, much darker in apical half; eyes amber; genae and clypeus light brown; face, occiput and vertex green; superior area of genae with a broad dark brown stripe, with a pale brownish stripe along its centre behind the eyes; greater part of disc of pronotum green, outer areas and carina brownish; outer areas of metazona with a large blackish triangular marking; lateral lobes brownish, with darker irregular markings except metazona which is green; pleurae brown; sternites and abdomen light brown; anterior and median legs brownish with irregular blackish spots and suffusion; basal half of posterior femora light brown; apical half green; superior external face with two dark brown spots; posterior tibiae light crimson, paler basally; spines narrowly tipped with black; posterior tarsi light reddish brown; anal area of elytra green; discoidal and mediastinal areas with dark brown reticulation, which becomes blackish brown in the apical portion of the mediastinal area; there are two broad transverse whitish fasciae between the costa and anal area; wings pale yellow basally, hyaline with smoky patches apically and with a broad smoky transverse fascia which is broadly interrupted at vena dividens, and touches the hind margin.

♀. General coloration brown; wings and posterior tibiae much paler than in the ♂.

Antennae (♂) about half as long again, (♀) very slightly longer than head and pronotum together; eyes regularly oval; interocular distance about twice as wide as frontal ridge between antennae; fastigium from above truncate apically, lateral margins convex, more so in the ♂; surface impressed; frontal ridge in profile (♂) feebly rounded, (♀) almost straight; from the front (♂) margins parallel, surface sulcate throughout and punctate; (♀) margins somewhat constricted below median ocellus; surface of head punctate; genae with a feeble diagonal sulcus; anterior margin of pronotal disc obtuse angulate; posterior margin (♂) acute angulate, with the sides feebly concave; (♀) rectangular, with the sides very feebly concave; anterior and inferior margins of lateral lobes (♂) sinuate; anterior margins (♀) sinuate; inferior margins (♀) broadly rounded; posterior margins (♂ and ♀) feebly concave; pronotum rather strongly impressed in the prozona; surface of disc punctate; of lateral lobes rugulose punctate; surface of pleurae rugulose punctate; supra-anal plate (♂) triangular, with the apex narrowly rounded, and the sides thickened, constricted near the apex; surface broadly sulcate apically and basally; on each side of the basal sulcus is a carina which reaches as far as the middle of the plate, then diverges to the sides; subgenital plate (♂) conical, hirsute; supra-anal plate (♀) triangular, with the apex rather broadly rounded and with a broad median sulcus reaching just beyond the middle; subgenital plate (♀) quadrate with a feeble rounded median apical projection; cerci (♂) simple, somewhat compressed laterally basally; elytra (♂) rotundato-truncate apically; (♀) truncate apically.

Described from one ♂ (type), Kitope, and one ♀, Tindiga.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	19	5	20	13
♀	29	6	27	16

Gastrimargus africanus, Sauss.

A very abundant species in grassland in bush or open country. Taken at Kilosa; Kondoa-Irangi; Mtugutu (Dodoma dist.); Kitope (Dodoma dist.); Kissaki; Uluguru Mts.; Bukene; Dar-es-Salaam.

Gastrimargus volkensi, Sjöst.

Two ♂'s and two ♀'s: Uluguru Mts. One ♂ and three ♀'s: Kilosa.

Gastrimargus longipes, Sjöst.

One ♀: Kitope.

Locusta migratoria, L.

Three ♀'s: Dodoma; Kilosa; Tindiga. No swarms were observed in these localities.

Trilophidia spp.

Three or more species were collected.

Tmetonota dispar, sp. n. (Plate VI, figs. 8, 9; Plate VIII, fig. 19.)

Antennae dark brown with irregular dark brown bands; eyes dark amber; general coloration of head and body dark blackish brown; elytra brownish, darker basally, and with a dark brown median fascia; wings pale reddish orange except for the costal and outer areas, which are infumate; in the ♀ the colour is paler. Posterior tibiae blackish, whitish apically and with a median whitish band and a whitish band near the knee.

Antennae filiform, slightly longer in the ♂ and slightly shorter in the ♀ than the head and

pronotum together; eyes regularly oval, interocular distance about twice as wide as frontal ridge between the antennae; frontal ridge from the front strongly sulcate; surface irregularly tuberculate; margins constricted above and below median ocellus, arcuate round ocellus, and strongly divergent below lower constriction; in profile feebly rounded and somewhat irregular; surface of face strongly rugose, tuberculate; surface of occiput strongly tuberculate; genae irregularly sulcate, tuberculate; fastigium transverse, very strongly impressed and tuberculate, not at all separated from frontal ridge; margins strongly thickened; median carina of pronotum cristate and distinctly divided into three parts; lateral carinae irregular and strongly tuberculate; pronotum laterally compressed in prozona; anterior margin of disc obtuse-angulate and rather irregular; posterior margin rectangular, sinuate and irregularly thickened; anterior margins of lateral lobes sinuate; posterior margins almost straight; anterior half of inferior margins straight, and posterior half feebly rounded, the whole irregularly thickened; surface of disc and lateral lobes strongly rugose and tuberculate; lateral carinae very strongly tuberculate; surface of pleurae very strongly and irregularly impressed; elytra (♂) rounded apically with the costal lobe moderately developed; slightly more than one and a half times as long as posterior femur; (♀) narrowly rounded apically; equal in length to posterior femur; costal lobe strongly developed; wings (♂) slightly less than elytra in length; (♀) four-fifths as long as elytra; posterior femora robust, with the oblique ridges strongly and irregularly impressed; abdomen laterally compressed and carinate dorsally; supra-anal plate (♂) subacute apically, with the lateral margins somewhat irregular and the surface strongly and irregularly impressed and sulcate; subgenital plate (♂) conical with a deep median basal depression; supra-anal plate (♀) narrowly rounded apically, compressed laterally, with a strong median transverse carina and a deep basal depression; surface strongly rugose; subgenital plate (♀) quadrate with a median apical projection; cerci ♂ and ♀ simple; clypeus, legs and sides of abdomen hirsute.

Described from one ♂ and two ♀'s, including the type: Shinyanga.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	13	4	14	8
♀	21	6	12	12

Acrotylus patruelis, H. Sch.

A common species preferring bare ground, roads and paths as a habitat.

Localities:—Kissaki; Kilosa; Muheza; Dar-es-Salaam; Kimamba; Tubugwe (Dodoma dist.); Uluguru Mts.; Nyegezi; Chilangali; Mhindulo.

Acrotylus junodi, Schult.

Dar-es-Salaam. A series of eight males and six females with the colour of the basal area of the wings ranging from pale whitish yellow to lemon yellow. Nine males and five females with the colour of the basal area of the wings ranging from very pale rose to deep rose are referable to ab. **rubescens** (ab. nov.).

Acrotylus angulatus, Stål.

One ♂: Chilangali.

Acrotylus hyalinus, Bol.

Dar-es-Salaam; Kilosa; Chilangali; Bukene.

Conipoda gracilis, sp. n. (Plate IX, figs. 34, 35.)

Antennae greyish brown with narrow dark brown bands; eyes light yellowish brown; ace and genae brownish white; occiput greyish brown; genae with a blackish-brown stripe

along superior margin behind the eyes; pronotum greyish brown with brown spots along all margins except anterior margin of disc and inferior margins of lateral lobes; lateral margins of prozona of disc and superior area of prozona of lateral lobes suffused with blackish brown; superior area of metazona of lateral lobes brownish; pleurae greyish brown; abdomen light yellowish brown with a bluish suffusion and a whitish spot dorsally on segments 1–6; anterior and median legs brownish white with indefinite brownish fasciae; posterior femora greyish with two rather indistinct brownish fasciae on superior faces and part of external face; carinae and oblique ridges with brownish-black spots; posterior tibiae pale blue, with the condyle dark blue, and a dark blue fascia on the basal side of the middle and a pale whitish band between that and the base; spines whitish, narrowly tipped with blackish brown; posterior tarsi whitish; elytra greyish brown, with a brown maculation; wings pale blue basally, hyaline apically.

Antennae filiform, about one and a half times as long as head and pronotum together; eyes spherical; interocular distance about one and a third as broad as frontal ridge between antennae; fastigium from above elongate, oval, much longer than broad, apex subacute, with the angle rounded; sides almost parallel; surface concave; frontal ridge from the front sulcate for the greater part of its length, but becoming smooth near clypeus; margins sinuate and widening strongly near clypeus; surface smooth with scattered punctures; in profile straight; occiput in profile feebly rounded, ascending; fastigio-facial angle broadly rounded; surface of head smooth. Anterior margin of pronotal disc almost straight, thickened, with a median concavity; posterior margin obtuse angulate with the angle rounded; anterior and posterior margins of lateral lobes very feebly sinuate; inferior margins sinuate with the posterior half irregularly thickened; transverse sulci distinct, the third sulcus intersecting the disc before the middle; surface of prozona smooth and very feebly punctate; metazona punctate; median carina of disc in profile straight, ascending feebly and strongly intersected by transverse sulci in prozona; in metazona feebly arcuate; surface of pleurae smooth, with scattered punctures; inner margins of meso-sternal lobes rectangular; meso-sternal interspace about as broad as lobes; inner margins of meta-sternal lobes rounded; meta-sternal interspace ovate; apex of the abdomen in the ♂ type not reaching the apex of the posterior femora; in the ♀ paratype it just reaches the apex.

Supra-anal plate (♂) triangular, as broad as long, apex narrowly rounded, sides feebly constricted basally, and with a feeble basal longitudinal sulcus; subgenital plate (♂) conical, with three broad depressions basally; supra-anal plate (♀) triangular, with the apex broadly rounded; strongly compressed laterally basally; surface irregularly impressed; subgenital plate (♀) quadrate with the apical margin broadly rounded and with a median apical projection; cerci (♂) short, simple and feebly constricted near apex; oblique ridges on posterior femora sublaminate; inner spurs of posterior tibiae twice the length of the outer ones.

Described from 1 ♂ (type) and 4 ♀'s, Dar-es-Salaam; 2 ♀'s, Kidai; 1 ♀, Kipera, and 4 ♀'s, Kilosa.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	17·5	4	19	11
♀	25	4·5	24	13·5

Chrotogonus rotundatus, Kirby.

Kipera; Kilosa; Mlemu (Dodoma dist.).

Chrotogonus rendalli, Kirby.

Dar-es-Salaam; Kilosa.

Maura modesta, Bol. (Plate VII, fig. 14.)

Face and antennae black; remainder of body ashy, except sternites and ventral surface of abdomen which are shining black with a faint reddish suffusion and fine whitish maculation; anterior legs black; median legs black with irregular ashy markings; posterior femora black, with patches of ashy and light brown; posterior tibiae and tarsi black.

Antennae moniliform, with the apical segment equal to about three of the other segments; equal to pronotum and occiput in length; surface finely punctate and apically feebly hirsute; eyes oval, with the front and basal margins very feebly rounded, equal to fastigium in length; interocular distance slightly less than greatest fastigial width; frontal ridge in profile strongly concave; from the front, margins very irregular; surface sulcate for a short distance from the vertex, then smooth, then strongly punctate rugulose; fastigium horizontal, parabolic, longer than broad, with a fine median longitudinal sulcus; surface of head strongly rugulose punctate; occiput with an irregular median longitudinal carinula; median carina of pronotum in profile irregular; anterior and posterior margins of pronotal disc rounded and irregularly thickened; anterior margins of lateral lobes feebly rounded; posterior margins almost straight and thickened; inferior margins irregularly sinuate and thickened; surface of pronotum very strongly rugose and punctate, and with two irregular rounded tubercles on each side of the median carina near the anterior margin and numerous irregular ridges; surface of pleurae strongly rugose punctate.

Abdomen strongly carinate dorsally, with a median tubercle at the apex of the first to the ninth segments; surface strongly rugose punctate dorsally and shining and punctate ventrally; supra-anal plate triangular with the apex narrowly rounded and the sides almost straight; subgenital plate trapeziform with a long median apical projection reaching to three-quarters of the length of the inferior valves of the ovipositor; ovipositor valves slender; surface smooth with a few scattered hairs; elytra coriaceous, narrowly rounded apically; reaching to the base of the posterior femora; wings about a third as long as elytra; oblique ridges on external faces of posterior femora irregular, forming a network.

One ♀: Ilonga (Kilosa). One ♀: between Uliya and Kidete.

Total length.	Pronotum.	Elytra.	Posterior femora.
mm.	mm.	mm.	mm.
37	9·5	8·5	14

Petasia fuscorosea, Sjöst.

Kilosa.

Parapetasia impotens, Karsch.

Three ♂'s: in temperate rain forest near Segoma in the Usambara Hills.

Phymateus aegrotus, Gerst.

Kitalala. Two ♀'s.

Phymateus purpurascens, Karsch.

Uluguru Mts.

Phymateus viridipes, Stål.

Kilosa.

Two small swarms in the second instar were found at Kilosa feeding on *Holarrhena febrifuga*, Kotsch, and were kept until they reached the adult stage when an invasion of "siafu" (driver ants) wiped the colony out.

They completed their metamorphosis at the end of March. During the day

the majority would rest motionless on the glass front and sides of the cage, while a few others rested on the food-plant. During the nymphal stage, they were usually in compact masses and were very restless, a slight movement on the part of one individual would at once set the whole swarm moving. In this stage also they seemed to prefer resting on the sides of the cage, and in the early morning would always be on that side of the cage first reached by the sun's rays. No attempts at copulation were observed.

Tanita dispar, sp. n. (Plate VIII, figs. 28, 29.)

General coloration grass green, with a row of yellowish tubercles, which extend from the vertex to the eyes, thence across the genae and along the inferior margin of the lateral lobes of the pronotum; wings rose except costal area which is hyaline and greenish; antennae purplish; eyes dark amber; abdomen light brown, with dark brown stripe along the dorsal carina.

Antennae moniliform, somewhat compressed dorso-ventrally at the base; terminal segment feebly pointed; equal to head and pronotum together (♂), or equal to head and prozona of pronotal disc (♀); eyes globose; interocular distance three-quarters greatest fastigial width; frontal ridge from the front very narrow, sulcate throughout, the sulcus and margins being rather indistinct near clypeus; margins sinuate; surface smooth, but somewhat foveolate near clypeus; in profile strongly concave; fastigium from above rotundato-angulate apically; lateral margins feebly concave; surface punctate and with two deep diagonal sulci converging towards apex; apical and lateral margins thickened; fastigium in profile feebly declivent; surface of face punctate with scattered tubercles; of genae feebly punctate, tuberculate, the tubercles being more prominent between the base of the eye and the inferior anterior angle of the lateral lobes of the pronotum; occiput feebly rugulose, with scattered tubercles and a strong median longitudinal carina; anterior margin of pronotal disc feebly sinuate (♂), feebly rounded (♀); anterior margins of lateral lobes narrowly rounded; posterior margins sinuate; inferior margins sinuate; surface rugulose with scattered tubercles on the disc and superior margins of lateral lobes and strongly tuberculate along the inferior margins of the lateral lobes; pleurae rugulose punctate, with scattered tubercles and a group of tubercles near the inferior margins.

Supra-anal plate (♂) triangular, slightly longer than broad, with the apex narrowly rounded, and the sides very feebly concave; subgenital plate (♂) broadly conical, with a deep short median sulcus; supra-anal plate (♀) triangular, about as broad as long, with the apex rounded; surface with scattered punctures; subgenital plate (♀) quadrate, with the apical margin sinuate and with a median apical projection; elytra narrowly rounded apically, slightly exceeding the apex of the posterior femora in length (♂), reaching the apex of the sixth abdominal segment (♀); femora of anterior and median legs irregularly sulcate, with scattered tubercles; oblique ridges on external faces of posterior femora irregular and irregularly thickened; inferior external face with a row of whitish tubercles.

Described from eight ♂'s and five ♀'s. Type ♂.
Bukene; Nyegezi.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	26	6	18	12
♀	35	7	17	14

Atractomorpha gerstaeckeri, Bol.
Kilosa; Msimbazi R.

Subfam. Pamphaginae.

Lamarckiana kilosana, sp. n. (Plate X, figs. 45, 46, 47, 48, 49.)

General coloration of the ♂, ashy brown, with darker and narrow longitudinal lines on the face and pronotum; antennae light brown; eyes dark amber; wings infumate; (♀) greyish with irregular brown and blackish spots, and with the inferior half of the genae and lateral lobes and the metazona of the pronotal disc dark blackish brown.

Antennae thirteen-jointed, segments 1 and 2 rounded; 3–13 strongly dorso-ventrally compressed, with the ventral surface slightly rounded; segment 13 sagittate; segments 12, 11, 9 and 7 with a projection at the external apical angle, these projections being more pronounced in the ♂; antenna of ♂ equal to about 11 segments of ♀ antenna in length; surface of head, pronotum and pleurae strongly granular; disc of pronotum strongly tuberculate especially on the carina in the metazona of the ♀; fastigium ovate with the apex subacute; angle of the crest of the pronotum formed at the third sulcus; superior and inferior median carinae of posterior femora strongly serrate, the serrations on the inferior carina being less regular and not so acute apically; abdomen of the ♀ strongly tuberculate dorsally; frontal ridge from the front (♂) feebly constricted above, strongly constricted below the median ocellus, then parallel for a short distance, then strongly divergent to clypeus; margins irregularly thickened, sulcate from vertex to the point of divergence of margins; frontal ridge (♀) deeply sulcate above the median ocellus; margins very irregularly thickened and tuberculate, particularly below the median ocellus; irregularly sinuate from vertex to below the median ocellus, then strongly arcuate to clypeus.

Described from one ♂, Kilosa; one ♂, Uliya, and four ♀'s (including the type), Kilosa.

	Total length.	Pronotum.	Elytra.	Posterior femora.
	mm.	mm.	mm.	mm.
♂	56	20	59	19
♀	73	18·5		25·5

Lamarckiana loboscelis, Schaum.

Kilosa. Two ♂'s and two ♀'s.

Lamarckiana spp.

Kilosa.

Subfam. Catantopinae.

Ixalidium obscuripes, sp. n. (Plate VIII, figs. 20, 21.)

Antennae light brown, with darker bands irregularly placed; eyes dark amber brown; general coloration of body blackish brown, with the face, sternites, lateral and ventral parts of abdomen light brown; superior interior faces, and exterior inferior faces of posterior femora black; inferior interior faces red; interior faces with a creamy brown spot near the knee; posterior tibiae blackish; anterior and median legs light brown, somewhat darker, and finely spotted with dark brown on their exterior faces; posterior tarsi light brown; meta-thoracic episternum light brown; meta-thoracic epimeron shining black.

Antennae basally compressed, almost as long as head and pronotum together; eyes broadly oval; interocular distance slightly less than greatest fastigial width; face reclinate; frontal ridge sulcate with the margins parallel and irregular, widening slightly near clypeal suture; in profile, concave below vertex, then almost straight; occiput very feebly rounded, with a strong median carinula reaching to the vertex; surface of head strongly punctate rugose; fastigium rectangular with the margins feebly rounded; median carina of pronotal disc in profile feebly rounded in prozona, almost straight in metazona; surface of disc

strongly punctate rugose; transverse sulci fairly deep but irregular; median carina of disc very distinct, smooth; anterior and posterior margins of disc and lateral lobes almost straight; inferior margin of lateral lobes broadly obtuse angulate, with the anterior half about twice as long as posterior half; superior surface of lateral lobes very strongly foveolate; pleurae strongly rugose punctate; prosternal tubercle transverse, rounded and with a median depression apically; abdomen strongly carinate dorsally; surface smooth ventrally, strongly rugose punctate dorsally; laterally compressed.

Supra-anal plate triangular, narrowly rounded apically, with a median sulcus; surface rugose; subgenital plate mucronate with a deep short sulcus basally; surface rugose punctate and feebly hirsute; cerci simple hirsute; oblique ridges on external faces of posterior femora regular, but interconnected especially towards the apex by irregular, ramifications; surface of superior external and internal faces strongly tuberculate.

Described from one ♂. Msimbazi River.

Total length.	Pronotum.	Posterior femora.
mm.	mm.	mm.
20	4	11

Oxya viridivitta, Walk.

Kilosa; Tindiga; Kalula.

Spathosternum pedestris, sp. n. (Plate XI, figs. 61, 62.)

Antennae purplish brown; eyes light amber with a dark brown suffusion; inferior half of genae and area above base of antennae whitish; superior half of genae and whole of face black; occiput and disc of pronotum pinkish brown, with a moderately broad median longitudinal stripe extending from the base of the disc to the vertex; superior area of lateral lobes black; inferior area whitish; pleurae blackish with a median whitish band which corresponds with the area of the same colour of the lateral lobes; abdomen greenish brown; anterior and median legs greenish yellow; posterior legs pale amber; costal half of elytra blackish, anal half pale yellowish white.

Antennae filiform, feebly compressed dorso-ventrally; about as long as head and pronotum together; eyes oval with the front margin almost straight; face retreating considerably; frontal ridge in profile straight; from the front, sulcate with the margins straight and divergent from the vertex; surface punctate; interocular distance subequal to greatest fastigial width; vertex from above rounded apically with the angle of the lateral margins slightly greater than a right angle, and with a median longitudinal carinula and a short transverse sulcus near the apex; surface impressed on each side of carinula; fastigium descending slightly; occiput feebly rounded, with a median longitudinal carinula; surface of face rugulose punctate, of genae and occiput punctate; anterior margin of pronotal disc rounded; posterior margin obtusely excised; anterior margins of lateral lobes almost straight; posterior margins concave; inferior margins sinuate; median carina of pronotal disc and transverse sulci distinct, the basal sulcus being comparatively near the posterior margin; lateral carinae indistinct; surface of lateral lobes strongly punctate rugulose with deep foveolae just below lateral carinae; surface of disc rugulose punctate; prosternal spine transverse, strongly compressed anteriorly-posteriorly, bilobate apically; abdomen carinate dorsally, surface punctate; supra-anal plate sagittate with a deep median longitudinal sulcus in the basal half; the basal lateral surface strongly compressed; subgenital plate conical, and somewhat hirsute; cerci simple; elytra coriaceous, reaching just beyond the base of the posterior femora; wings vestigial.

Described from one ♂ (type): Mhindulo.

Total length.	Pronotum.	Elytra.	Posterior femora.
mm.	mm.	mm.	mm.
17·5	4·25	4	9

Tristria brunneri, Karsch.

Kilosa. One ♀.

Tristria sudanensis, Karny.

One ♂ and two ♀'s: Kilosa. Four ♀'s: Tubugwe.

Tristria coerulipes, Uv.

One ♀: Kilosa.

Oxyrrhepes procera, Burm.

Kilosa; Tindiga.

Anoxyrrhepes natalensis, Uv.

Tubugwe; Kilosa; Kalula.
In tall grass.

Homoxyrrhepes punctipennis, Walk. (Plate V, fig. 7.)

Two ♂'s and four ♀'s: Kilosa.

Metapa usambarica, Karsch. (Plate VII, figs. 12, 13.)

Zigi River.

Ischnacrida monteiroi, Bol.

Kalula.

Rhamphacrida kraussi, Bol.

Kalula; Kilosa.

Acanthoxia gladiator, Westw.

One ♂, two ♀'s: Kilosa.

Mesopsis laticornis, Krauss.

Kilosa; Tindiga; Myombo; Kalula; Bukene.

Total length.		Head.		Pronotum.		Elytra.		Posterior femora.	
♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
mm.		mm.		mm.		mm.		mm.	
57	66·5	10	13	6	8	28	38	17	22

Krauss (*Orthopteren von Senegal*, 1877) gives the following measurements:—

51	68	9	12	6	8	26	37	14	21

Anthermus, sp.

One ♂ and one ♀: Kalula.

I have refrained from describing this as a new species, having so little material at my disposal. It is near to *Anthermus granosus*, Stål, but differs in the colour of the wings, which are very pale violet, and in the colour of the posterior tibiae being pale purplish apically. The vertex is more narrowly rounded apically, and the margins of the frontal ridge are parallel above the ocellus, not arcuate in the male.

Anthermus acutifrons, sp. n. (Plate XI, figs. 63, 64.)

General coloration pale reddish brown, with indefinite darkish dots; antennae purplish brown; abdomen light brownish yellow, with a bluish suffusion dorsally and a whitish spot

on each side of the dorsal carina on the first to the fifth basal segments; wings very pale violet; posterior femora with blackish spots on the external carinae; posterior tibiae pale green stramineous.

Antennae with the third to seventh segments dorso-ventrally compressed; slightly longer than the head and pronotum together; eyes rather narrowly oval, with the front margin almost straight; interocular distance slightly greater than width of frontal ridge between antennae; fastigium from above pyriform, descending feebly; frontal ridge with the margins arcuate above, constricted below median ocellus, then divergent towards clypeus, sulcate, punctate near vertex, in profile feebly concave; fastigio-facial angle acute with the apex narrowly rounded; lateral facial carinae irregularly sinuate; surface of head rugose; anterior margin of pronotal disc broadly rounded, with a very feeble median concavity; posterior margin obtuse angulate, rather more rounded in the ♀; anterior and posterior margins of lateral lobes feebly sinuate; inferior margins obtuse angulate, with the anterior half concave; margins of disc and lateral lobes irregularly thickened; median carina of disc distinct on metazona, irregular and somewhat indistinct on prozona; transverse sulci distinct, the first and second sinuate, the third straight; surface of pleurae rugose punctate; inner margins of meso-sternal lobes angulate and very narrowly separated; inner margins of meta-sternal lobes rounded and very narrowly separated; abdomen carinate dorsally; supra-anal plate (♂) triangular, very deeply depressed laterally, and with a broad median longitudinal sulcus; subgenital plate (♂) conical with the apex narrowly rounded; supra-anal plate (♀) triangular, with the apex broadly rounded, and with the sides very strongly compressed; subgenital plate (♀) quadrate, with a median apical projection; cerci (♂) long, laterally compressed in the basal half, then slender, broadly curving upwards and feebly incurved near apex; laterally apically on the external face with an ovoid depression; cerci (♀) simple, short; elytra rather narrow, exceeding the apex of the posterior femora by about a seventh of their length, with the costal lobe moderately well developed and the apex rotundato-truncate; oblique ridges on posterior femora regular, but irregularly thickened; superior median carina of posterior femora broadly but feebly serrate; all legs with scattered hairs.

Described from one ♂ (type) and one ♀: Kalula.

	Total length.	Pronotum.	Elytra.	Posterior femora.
	mm.	mm.	mm.	mm.
♂	19	4	16	10
♀	25	6	20	14

Anacridium moestum, Serv.

Uluguru Mts.; Tindiga; Kilosa.

Found as a rule in thorn bush country and usually resting on the branches of trees.

Cyrtacanthacris aeruginosa aeruginosa, Stoll.

Kilosa.

Cyrtacanthacris aeruginosa **submaculata,** subsp. n.

Two ♀'s: Tindiga.

Similar to *C. aeruginosa aeruginosa*, Stoll, but differs in the following respects:—

Relatively smaller and less robust, the anterior and posterior margins of the pronotal disc more acute, and the median carina of the pronotum in profile is less rounded; the spots on the elytra are moderately distinct and the reticulation is pale. The colour of the posterior tibiae is greenish purple, not reddish orange.

It differs from *C. aeruginosa flavescens*, Walk., in having spots on the elytra, the yellowish stripe in the mediastinal area of the elytra much less pronounced, and is less robust.

Cyrtacanthacris tatarica, L.

Kondoa-Irangi; Uluguru Mts.; Kilosa; Bukene; Dar-es-Salaam; Nyegezi; Mlemu (Dodoma dist.); Kissaki; Tindiga; Kitope (Dodoma dist.); Tubugwe (Dodoma dist.); Mkalama; Chilangali.

Ornithacris cyanea cyanea, Stoll. (Plate V, fig. 3; Plate IX, fig. 38.)

Two ♂'s: Kalula; two ♂'s and three ♀'s: Mkalama.

Dr. H. C. Blöte of the Leiden Museum was kind enough to make photographs from the type of *Gryllus Locusta cyaneus* preserved in that Museum, from which it is quite clear that the subspecies called *cyanea* by Uvarov (*Ann. Mag. Nat. Hist.*, ser. 9, Vol. XIII, 1924, p. 10) and figured under that name by Bolivar (*Voyage Baron M. Rothschild en Ethiopie, Orthoptères*, 1922, p. 187, pl. 10^2, fig. 3) is different from the typical one. The difference is mainly in the presence of well-marked pale pattern on the pronotum in the type (Plate IX, fig. 38), the other subspecies having the pronotum practically unicolorous; this uniformly coloured subspecies with purple wings has been described by Sjöstedt (*Kilimandjaro Meru Exped. Orthoptera, Acridiodea*, 1909, p. 186) under the name var. *orientalis*, Sj., and this name must stand for it.

There are thus two subspecies of *O. cyanea* with purple wings, and they may be separated as follows:—

1 (2). Lateral pronotal lobes uniformly dark; elytra with the pale fasciae narrower than the dark ones . . . . . *O. cyanea orientalis*, Sj.

2 (1). Lateral pronotal lobes with a broad pale fascia above the middle; elytra with the pale fasciae at least as broad as the dark ones. *O. cyanea cyanea*, Stoll.

The distribution of the two subspecies in E. Africa is as yet imperfectly known, but it seems that the true *cyanea* belongs to the drier areas.

Ornithacris cyanea magnifica, Bol.

Uluguru Mts.; Tubugwe (Dodoma dist.); Mkalama; Kilosa.

Ornithacris cyanea pictula, Walk.

Tindiga; Chilangali; Mkalama.

Kraussaria dius, Karsch. (Plate V, fig. 1.)

One ♂ from Tindiga, one ♀ from Kilosa, and one ♀ from Kondoa-Irangi.

The coloration described from freshly killed specimens is as follows:—

Antennae pale greenish yellow; eyes pale pinkish brown with brown vertical lines. Head, body and anterior and median legs dark emerald green; posterior femora dark emerald green with a reddish stripe along part of the basal half of the superior exterior carina, and with the genicular arches brownish green; posterior tibiae greenish yellow; spines on posterior tibiae pale yellow, tipped with dark reddish brown; posterior tarsi green; elytra semi-transparent; reticulation in the mediastinal area and upper part of the discoidal area and basal part of anal area green, in remainder reddish; wings pale yellow basally; outer area colourless; costa greenish; principal longitudinal veins reddish.

Rhytidacris punctata, Kirby.

Kilosa; Uliya; Mkalama; Kalula.

Rhytidacris tectifera, Karsch.

Kilosa.

Nomadacris septemfasciata, Serv., ph. *coangustata*, Luc.

Uluguru Mts.; Kilosa; Mkalama; Kalula.

Acanthacris lineata flava, Stoll.

Uluguru Mts.; Mkalama; Tubugwe (Dodoma dist.); Dar-es-Salaam.
An abundant species in open bush country.

Acridoderes crassus, Bol. **aequalis,** subsp. n. (Plate IX, fig. 37.)

Differs from *A. crassus*, Bol., in the following respects :—

Distinctly smaller; the anterior and posterior angles of the pronotal disc are more acute; the sculpture of the pronotum and pleurae is finely rugose, and the pro- and metazona of the pronotum are equal in length.

One ♂ and four ♀'s : Kalula.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	30·5	8	24	15·5
♀	40·5	12	36	27

Hemiacris spp.

Kalula; Kilosa.

Abisares viridipennis, Burm.

Kilosa; Myombo; Chilangali.
In fairly dense secondary forest.

Bocagella lanuginosa, I. Bol.

One ♀: Kalula.

Parepistaurus deses, Karsch. (Plate VII, fig. 16.)

One ♂ and one ♀, Uluguru Mts., at an elevation of about 6000 ft.

Eupropacris cylindricollis, Schaum.

Uliya, Segoma, in temperate rain forest.

Eupropacris abbreviata, sp. n. (Plate VIII, fig. 32; Plate XI, fig. 60.)

Antennae black with a brownish-grey pubescence; eyes cobalt blue; head chrome yellow with a cobalt-blue suffusion on the face, a median cobalt-blue stripe on the occiput behind the eyes and on the genae; pronotum chrome yellow, with a slight cobalt-blue suffusion in the metazona and a large irregular blue marking on the lateral lobes. Pleurae and sternites chrome yellow with a bluish suffusion; abdomen chrome yellow with a cobalt-blue suffusion at the apex of each segment; all legs chrome yellow suffused with cobalt blue; elytra and wings pale chrome orange.

Antennae slightly compressed and almost as long as head and pronotum together; surface punctate and sparsely pilose. Eyes prominent, oval. Face reclinate. Frontal ridge sulcate for the whole of its length; margins parallel but slightly constricted below the median ocellus, in profile feebly concave; surface of face strongly punctate; surface of genae feebly punctate; occiput in profile rounded, surface mostly feebly punctate, but somewhat fossulate behind the eyes; interocular distance equal in length to the second and

third antennal segments together; fastigium of the vertex sloping, surface depressed and rugulose; margins raised.

Surface of pronotum coarsely rugose, with a few scattered hairs on disc and lateral lobes; anterior margin of disc broadly rounded, and very feebly concave; posterior margin broadly rounded; anterior and posterior margins of lateral lobes almost straight; inferior margin broadly obtuse angulate; median carina distinct and strongly punctate; transverse sulci deep; superior anterior surface of lateral lobes very strongly pitted; prosternal tubercle strongly compressed laterally and anteriorly-posteriorly, and slightly inclined backwards; surface coarsely punctate and sparsely hirsute; rounded apically; surface of pleurae strongly rugose and punctate; elytra reaching to half the length of the posterior femora; rounded apically and with scattered hairs along the anal margin; wings slightly shorter than elytra; cerci conical, hirsute; supra-anal plate triangular with the apex subacute, with a deep sulcus apically and basally and broadly depressed laterally; subgenital plate short, rounded apically and hirsute; abdomen compressed laterally and hirsute dorsally and ventrally; oblique ridges on posterior femora regular; superior median carina feebly serrate; superior face strongly impressed and punctate; genicular arches broadly rounded; genicular lobes rounded apically with the inferior margins bisinuate; all legs sparsely hirsute.

Described from one ♂ taken at Kilosa. Colour description from freshly killed specimen.

This species differs from all known species of *Eupropacris* by the abbreviated elytra and wings.

Total length.	Pronotum.	Elytra.	Posterior femora.
mm.	mm.	mm.	mm.
26	6	11	13

In the dried specimen the coloration is as follows :—

Antennae brownish black; eyes amber, with a faint iridescence; head dark lemon yellow with a dark blue suffusion on the face, a dark blue longitudinal stripe on the occiput and a dark blue suffusion behind the eyes and on the genae. Disc of pronotum brownish green; lateral carinae dark lemon yellow; metazona of lateral lobes brownish green; greater portion of prozona dark blue, remainder brownish yellow; pleurae and sternites dark brown with a dark blue suffusion; abdomen brown, with a dark blue suffusion at the apex of each segment; anterior and median legs dark lemon yellow with a bluish-green suffusion; exterior faces of posterior femora dark greenish blue, remainder brownish yellow with a greenish suffusion; elytra and wings pale chrome orange.

Eupropacris obscura, sp. n. (Plate VIII, fig. 31.)

Antennae brownish; eyes burnt sienna; head bluish green with the inferior half of the genae and the sides of the occiput yellow; pronotum bluish green with the sides of the disc and the superior and inferior margins of the lateral lobes yellow; pleurae bluish green with yellow on the anterior part of the meso- and meta-pleurae, sternites bluish green irregularly marked with yellow; abdomen greenish yellow with the apical areas of each segment bluish green; anterior and median legs bluish green suffused with yellow; posterior femora bluish green with the superior exterior face and the exterior inferior carina yellow; posterior tibiae bluish, apically yellowish; all tarsi brownish; elytra brownish green, slightly paler in apical area; wings salmon pink, very feebly suffused with brownish green apically.

Antennae filiform, (♂) about one and a half times as long as head and pronotum, (♀) about a fifth longer than head and pronotum; eyes regularly oval; interocular distance not broader than antennae; face retreating somewhat; frontal ridge in profile, straight;

from the front, margins parallel but slightly constricted below median ocellus; sulcate; surface strongly punctate; fastigium from above truncate with the lateral margins slightly concave; surface punctate and with a median depression; surface of face strongly rugulose punctate; of occiput and genae punctate; median carina of pronotum in profile (♂) almost straight, (♀) straight in prozona, feebly arcuate in metazona; anterior margin of disc feebly rounded; posterior margin rotundato-angulate; anterior and posterior margins of lateral lobes almost straight; inferior margins obtuse angulate; surface strongly rugulose punctate; superior area of prozona of lateral lobes with two foveolae; transverse sulci distinct; median carina of disc (♂) distinct but irregularly punctate in prozona, (♀) distinct on metazona only; prosternal spine, strongly compressed laterally and anteriorly posteriorly and slightly inclined backwards; apex rounded; surface of pleurae strongly rugulose punctate.

Supra-anal plate (♂) triangular, apex acute, (♀) triangular with the apex less acute than in the ♂, with a deep median longitudinal sulcus which reaches to the centre and with an irregular transverse carinula; subgenital plate (♂) conical; surface punctate and feebly hirsute, (♀) quadrate, with a median apical projection; cerci ♂, simple, slightly constricted near apex.

Differs from *E. cylindricollis*, Schaum, in having the pronotum less constricted, shorter elytra and posterior femora. In coloration the green and yellow is not sharply defined. The cerci in the ♂ are shorter and broader basally than those of *E. genualis*, Walk.

Described from three ♂'s (including the type) and two ♀'s. In secondary forest, Ilundwe R., nr. Kidode.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	24·5	6	21	13
♀	37	7	30	16

Catantops decipiens, Karsch.

Kalula; Kilosa.

Catantops minimus, Karny.

Kalula.

Catantops brunneri, Karny.

Tindiga.

Catantops melanostictus, Schaum.

Kilosa; Mhindulo; Korogwe; Muheza; Bukene; Tubugwe (Dodoma dist.); Tindiga; Chilangali; Mlemu (Dodoma dist.); Dodoma; Kissaki; Dar-es-Salaam; Myombo; Kalula.

Catantops sulphureus, Walk.

Kilosa; Tubugwe (Dodoma dist.); Dar-es-Salaam; Dodoma; Myombo.

Catantops adustus, Walk.

Kalula; Tindiga; Kilosa; Tubugwe (Dodoma dist.); Mkalama.

Catantops hemipterus, sp. n. (Plate IX, fig. 43.)

Antennae pale stramineous basally, reddish apically; eyes and head yellowish brown with a narrow dark reddish-brown band behind the eyes; pronotum yellowish brown with a broad dark reddish-brown band which covers practically the whole of the lateral lobes

except a narrow portion of the base, which is whitish; sternites and inferior area of meso-thoracic episternum yellowish brown; superior area of the meso-thoracic episternum and all the meso-thoracic epimeron dark reddish brown, except a small portion of the superior area, which is yellowish brown; inferior margin of the meso-thoracic epimeron black; meta-thoracic episternum dark blackish brown with a median diagonal yellowish band; abdomen light brown with dark brown irregular markings on the first to the sixth segments dorsally, which is separated, forming two spots on the fifth and sixth segments; anterior and median legs brownish yellow; posterior femora brownish or greenish yellow, with the inferior face black and three black spots on the internal face; sides of the knees black; there are no markings on the external face; posterior tibiae pale greenish yellow, with black tipped spines and a blackish suffusion near the apex and medially on the inner surface; elytra with the mediastinal area and the greater part of the discoidal and apical areas brownish; remainder of elytra yellowish brown; wings pale lemon yellow with a metallic lustre.

Antennae filiform, subequal to head and pronotum together; eyes oval with the front margin almost straight; interocular distance subequal to the width of frontal ridge between antennae; frontal ridge from the front feebly depressed round median ocellus, in the remainder smooth and irregularly punctate; in profile almost straight; occiput in profile feebly rounded; surface of face and genae strongly punctate; of occiput less so; median carina of pronotum in profile almost straight; anterior margin of pronotal disc feebly rounded; posterior margin rotundato-angulate; anterior margins of lateral lobes feebly sinuate; posterior margins almost straight; inferior margins rotundato-angulate with the apical and basal halves feebly concave; surface of disc punctate, of lateral lobes punctate foveolate; abdomen carinate dorsally ; supra-anal plate triangular, rounded apically with a deep median sulcus which extends from the base to a transverse median carina; sub-genital plate quadrate, with a median apical projection; elytra very narrowly rounded apically, reaching just beyond half the length of the posterior femora.

Allied to *C. ornatus*, Karny, but with the elytra (at least in the ♀) abbreviated. Described from one ♀: Kalula.

Total length.	Pronotum.	Elytra.	Posterior femora.
mm.	mm.	mm.	mm.
27	6·5	14	16

Catantops curvicercus, sp. n. (Plate VIII, figs. 22, 23, 24.)

Antennae brownish stramineous, paler apically, and black on the ventral surface in the basal third; eyes dark amber; face brownish white; inferior half of genae brownish white; superior half shining blackish brown; occiput, vertex and pronotal disc brown; lateral lobes stramineous, darker in the metazona and with a blackish brown rectangular marking occupying the greater part of the prozona; meso-thoracic episternum stramineous with a narrow irregular brown band along the inner margin; meso-thoracic epimeron dark brown; meta-thoracic episternum stramineous basally; remainder dark brown with a median pale stramineous stripe; meta-thoracic epimeron dark brown; abdomen pale stramineous, with dark brown along the dorsal carina; anterior and median legs light brown with the tarsi greenish; posterior femora stramineous, darker on the upper face and with two diagonal broad black fasciae on the upper half of the external face; posterior tibiae pale crimson; spines tipped with black; elytra greyish brown with black suffusion and maculation in the mediastinal and apical areas; wings infumate, darker apically.

Antennae slightly longer than head and pronotum; eyes almost regularly oval; inter-ocular distance subequal to width of frontal ridge between antennae; frontal ridge from the front smooth, with scattered punctures and slightly impressed round ocellus; margins converging slightly above, feebly constricted below the median ocellus, then parallel; in

profile almost straight; fastigium from above rounded apically, with the sides very feebly concave; surface impressed and punctate; surface of head punctate; anterior margin of pronotal disc narrowly rounded; posterior margin rotundato-angulate; anterior margins of lateral lobes feebly sinuate; posterior margins feebly concave; inferior margins broadly obtuse angulate with the apical half feebly concave; surface of disc, metazona and inferior areas of prozona of lateral lobes rugulose punctate; remainder of lateral lobes smooth with scattered punctures and with foveolae along the superior margin; prosternal spine transverse, broadly rounded apically and feebly constricted basally; supra-anal plate (♂) pentagonal, with the basal half of the sides constricted; subgenital plate (♂) conical, narrowly rounded apically and with a deep median longitudinal depression in the basal half; supra-anal plate (♀) triangular, rounded apically, strongly constricted laterally and irregularly impressed; subgenital plate (♀) quadrate with a median apical projection; cerci (♂) strongly compressed laterally in the basal half, slender in the apical half, rounded apically, and strongly curving upwards, the angle formed being slightly greater than a right angle; elytra slightly exceeding the apex of the posterior femora; superior carina of posterior femora very feebly serrate.

Differs from *C. melanostictus*, Schaum, as follows:—Male cerci slender, laterally compressed in the basal half and curving upwards forming almost a right angle, with the apex rounded; body slightly more robust; the posterior margin of the pronotal disc is less rounded; the black markings on the external faces of the posterior femora are more distinct and have both the margins of the basal marking and the basal margin of the apical marking sub-parallel, whereas in *C. melanostictus* the basal black marking is club-shaped.

The ♂ cerci differ from those of *C. quadratus*, Walk., in being longer, more slender in the apical half and more greatly compressed in the basal half. The curve in the ♂ cerci of *C. quadratus* is regular and feeble.

Coloration similar to that of *C. melanostictus*, Schaum, but rather darker in most individuals.

Described from seven ♂'s and eight ♀'s. Type ♂.

Bukene; Tubugwe.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	22	4·5	17	12·5
♀	28	6	21	15·5

Catantops viridipunctatus, sp. n. (Plate V, fig. 5; Plate VIII, fig. 25.)

Antennae dark purplish brown; eyes light amber; body pale greenish brown with a pale greenish-yellow stripe along the lateral carinae of the pronotal disc and extending along the meta-thoracic episternum; inferior anterior area of meso-thoracic episternum pale greenish yellow; foveolae on the superior margin of prozona of lateral lobes blackish green; legs pale brownish green; posterior femora with small black spots on the superior median and internal and external carinae; abdomen pale greenish brown with a dark reddish-brown suffusion on segments one to eight, and a whitish brown spot on each side of the dorsal carina on segments five to seven inclusive; elytra pale greenish brown with light-brown or yellowish-brown cross-veinlets; wings pale salmon pink, paler apically.

Antennae, about as long as head and pronotum together, moniliform, feebly dorso-ventrally compressed in the basal half; surface finely punctate; eyes regularly oval, about as long as infra-ocular portion of genae; interocular distance equal to width of frontal ridge between antennae; margins of frontal ridge subparallel, irregularly and feebly sinuate, surface punctate, more strongly so near vertex; frontal ridge in profile almost straight; fastigio-facial angle broadly rounded; fastigium from above ovate, with a feeble pyriform

depression; occiput in profile feebly rounded; surface of face rugulose, of occiput and genae very feebly rugulose; occiput with scattered hairs; anterior margin of pronotal disc broadly rounded; posterior margin obtuse angulate; anterior and posterior margins of lateral lobes almost straight; inferior margins obtuse angulate with the anterior half feebly concave; median carina of disc distinct but irregularly thickened on the prozona between the first sulcus and the anterior margin and on the metazona, obsolescent between the first and third transverse sulci; median carina of disc in profile straight and deeply intersected by sulci on prozona and feebly arcuate in metazona; surface of pronotum rugulose punctate, with scattered hairs on the disc and two moderately large foveolae on the superior margins of the prozona of the lateral lobes; prosternal spine short, straight, with the apex rounded and moderately hairy; inner margins of meso-sternal lobes angulate and subcontiguous; inner margins of meta-sternal lobes rounded and contiguous; cerci short, laterally basally compressed, curving inwards feebly, bifurcate apically with the outer branch acute and feebly curving outwards and the inner branch truncate; supra-anal plate triangular, with the lateral margins sinuate, strongly laterally compressed and with a broad median basal sulcus and a feeble sulcus near the apex, which is narrowly rounded; subgenital plate hairy, conical, with the apex rounded; elytra narrow, narrowly rounded apically, exceeding the apex of the posterior femora by about a fifth of their length; wings relatively narrow. All legs with scattered hairs; superior median carina of posterior femora serrate, with the teeth moderately close together.

Described from two ♂'s (including the type): Tubugwe.

Total length.	Pronotum.	Elytra.	Posterior femora.
mm.	mm.	mm.	mm.
20	5	20·5	12

Catantops hirtus, sp. n.

General coloration ashy grey; lateral lobes somewhat darker; wings infumate apically, pale blue basally; posterior femora faintly spotted with black on external carinae; posterior tibiae brownish, spines broadly tipped with blackish red.

Antennae thick, feebly compressed dorso-ventrally; subequal to head and pronotum in length in the ♂; less than head and pronotum in length in the ♀ by about a quarter of their length; eyes hardly prominent, elongate ovate, with the front margin almost straight; interocular distance equal to half greatest fastigial width; frontal ridge in profile almost straight; from the front, margins feebly constricted below median ocellus and narrowing considerably towards vertex; surface feebly sulcate and strongly punctate; fastigio-facial angle slightly more than a right angle; fastigium from above rounded apically with the lateral margins concave; surface of head rugulose punctate, with scattered hairs; median carina of pronotum in profile straight; lateral carinae very indistinct; anterior margin of disc feebly rounded; posterior margin obtuse angulate with the angle rounded; anterior and posterior margins of lateral lobes almost straight; inferior margin obtuse angulate with the angle rounded, the apical half feebly concave, and the basal half straight; transverse sulci moderately distinct; surface of pronotum rugulose punctate and strongly foveolate in the superior area of the prozona of lateral lobes; prosternal spine narrowly conical, with the apex rounded, slightly inclined backwards; surface of pleurae strongly rugulose punctate; supra-anal plate (♂) triangular, with the lateral margins sinuate and the surface strongly depressed laterally basally; subgenital plate (♂) mucronate apically with a median longitudinal basal sulcus and an irregular depression laterally basally; cerci (♂) incurving feebly, bifurcate apically with the outer prong slightly longer; supra-anal plate (♀) broadly triangular, with the apex rounded, the lateral margins sinuate and the surface laterally basally compressed; subgenital plate (♀) quadrate with a median apical projection; posterior femora of the ♂ reaching the apex of the abdomen; in the ♀

they slightly exceed the apex of the abdomen; superior carina feebly serrate; elytra narrowly rounded apically.

Closely allied to *C. tukuyuensis*, Mill., but differs from it in the absence of black markings on the sides of the pronotum, and in the coloration of the wings and hind legs.

One ♂ (type) and one ♀: Kalula. Three ♂'s and one ♀: Tubugwe.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	21	5	18	11
♀	25	6	22	13

Cardenius formosus, sp. n. (Plate V, figs. 4, 4A.)

Antennae black with ten segments of the basal half narrowly banded apically with grey; eyes light yellowish brown with a dark brown suffusion and fine whitish maculation; head and body (except pronotal disc, occiput and external faces of posterior femora) stramineous; face, lateral lobes, pleurae and sternum finely maculate with black and rose-madder, the clypeus and labrum being less spotted; pronotal disc and occiput pale creamy brown; median carina narrowly and interruptedly marked with sulphur yellow; sides of median carina and superior margins of lateral lobes dark red; occiput with a fine longitudinal sulphur yellow line bordered with dark red; there is a narrow black stripe behind the eyes; abdomen with an interrupted narrow yellow stripe bordered with dark red, dorsally; laterally and ventrally with a very fine black maculation and rose madder spots and blotches; femora of anterior and median legs yellow stramineous; tibiae much suffused with black; tarsi black; exterior faces of posterior femora with the oblique ridges, median line and superior and inferior external carinae dark crimson; posterior tibiae black except for a small part of the basal external face which is stramineous; posterior tarsi black; elytra pale stramineous with the area between vena dividens and vena ulneris anterior black, and sometimes with irregular black spots in area discoidalis; wings hyaline, colourless.

Antennae moniliform, very feebly compressed dorso-ventrally; surface finely punctulate; very slightly longer than head and pronotum; eyes oval with the front margin almost straight; interocular distance equal to slightly more than greatest fastigial width; frontal ridge in profile almost straight; from the front (♂) margins almost parallel, compressed slightly below the median ocellus; sulcate; (♀) margins convex from vertex to just below median ocellus, then parallel but rather indistinct; impressed around median ocellus; (♂ and ♀) surface smooth with scattered punctures; fastigium descending slightly, transverse, truncate apically with the lateral margins very feebly rounded, impressed on each side of a median longitudinal carinula which extends backwards along the occiput; surface of face and genae (♂) feebly rugulose; (♀) genae smooth with scattered punctures, face rugulose punctate; occiput (♂ and ♀) smooth with scattered punctures; supra-anal plate (♂), triangular, rounded apically, sides somewhat compressed basally, with a short median basal sulcus and a median transverse carinula; subgenital plate (♂) conical, obtuse; cerci (♂) simple, compressed laterally basally and somewhat incurved.

Described from two ♂'s (including type): Kipera. One ♀: Kilosa. Colour description from fresh specimens.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	21	5	18	11·5
♀	30	8	24	17

Cardenius nigripes, sp. n.

General coloration brownish stramineous. Two basal segments of antennae brownish, remainder black; eyes dark amber; superior margins of lateral lobes black; carinula on occiput and median carina of pronotal disc sulphur yellow with a moderately broad black stripe on both sides; genae with a purplish spot behind the eyes; lateral lobes and pleurae irregularly spotted with purple; meso- and meta-thoracic episterna with a sulphur yellow diagonal carinula; prosternal spine tipped with pale crimson; abdomen spotted with pale crimson; elytra with a black stripe along the vena dividens and with four to five moderately large black spots along the discoidal area; femora and tibiae of anterior and median legs brownish stramineous; external carinae of posterior femora sulphur yellow, the superior carina with a narrow black stripe beneath it; posterior tibiae yellowish basally, black on internal face and greyish on external face; spines whitish tipped with black; all tarsi blackish; wings pale violet basally, hyaline apically.

Antennae moderately thick, feebly compressed dorso-ventrally; surface punctulate; slightly longer than head and pronotum together; eyes (♂) oval with the front margin almost straight; in the ♀ they are rather more narrow apically; interocular distance subequal to width of frontal ridge between antennae; fastigium from above truncate apically, with the lateral margins rectangular; surface with a feeble ovate depression, and a feeble median longitudinal carina; frontal ridge from the front, sulcate, margins subparallel, feebly sinuate, constricted near vertex; in profile almost straight; surface of face and inferior anterior parts of genae feebly rugulose; remainder of head smooth; anterior margin of pronotal disc feebly rounded with a feeble median concavity in the ♀; posterior margin obtuse angulate with the angle feebly rounded; anterior margins of lateral lobes almost straight; posterior margins very feebly sinuate; inferior margins rotundato-angulate, with the anterior half concave; median carina of disc almost straight in profile, slightly more rounded in the prozona of the ♀ than in the ♂; distinct, somewhat irregularly thickened, particularly in prozona; lateral carinae indistinct; surface of pronotum punctate, somewhat rugulose punctate on metazona; superior areas of lateral lobes foveolate, particularly in prozona; surface of pleurae rugulose punctate; supra-anal plate (♂) triangular, narrowly rounded apically, constricted and depressed laterally basally, and with a median basal sulcus; subgenital plate (♂) broadly conical; supra-anal plate (♀) triangular, rather broadly rounded apically, strongly compressed basally and with a median basal sulcus; subgenital plate (♀) quadrate, with a median apical projection; cerci (♂) simple, curving inwards slightly.

This species is similar to *C. nigropunctatus*, Bol., but differs in the following respects. It is slightly more robust, the frontal ridge from the front is more deeply sulcate, and the surface is smoother and less punctate; the fastigium of the vertex is narrower apically and the foveolae are smaller; the elytra hardly reach beyond the apex of the posterior femora; the hind margin of the pronotal disc is obtuse angulate with the angle less rounded. It is more robust than *C. guttatus*, Uv., and differs further in having a narrower fastigium, no foveolae on the occiput near the eyes, and the frontal ridge more deeply sulcate and more narrow; the angle of the posterior margin of the pronotal disc is more acute; the elytra barely exceed the apex of the posterior femora.

Described from one ♂ (type) and one ♀: Tubugwe.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	20·5	5	16	12
♀	27	7	21	16

Stenocrobylus crassus, sp. n. (Plate XI, figs. 57, 58, 59.)

General coloration ashy brown; sides of prozona of pronotum orange brown; superior margin of lateral lobes blackish in prozona; posterior femora light brown spotted with black; posterior tibiae and tarsi purplish; spines on tibiae light purple tipped with black; wings bluish, infumate apically.

Antennae filiform; eyes regularly oval, prominent; interocular distance equal to half greatest fastigial width; frontal ridge in profile feebly concave; from the front margins parallel; surface impressed round ocellus and strongly punctate; fastigium sub-horizontal, surface impressed and strongly punctate; surface of head strongly rugulose punctate; prozona of median carina of pronotum in profile feebly arcuate; metazona straight; anterior margin of disc feebly rounded with a slight median concavity; posterior margin broadly rounded and thickened; anterior margin of lateral lobes almost straight; posterior margin feebly sinuate; inferior margin broadly obtuse angulate with the angle rounded and the apical half feebly concave; pronotum somewhat compressed laterally in prozona; transverse sulci very distinct; surface of pronotum and pleurae strongly rugulose punctate; prosternal spine transverse, compressed slightly laterally, rounded apically and with a median apical depression; cerci simple and very slender in apical half; supra-anal plate broadly rounded apically; surface strongly punctate; subgenital plate quadrate with a strong median apical projection; oblique ridges on external faces of posterior femora distinct and fairly regular; elytra rather narrow and narrowly rounded apically; legs and apex of abdomen ventrally somewhat hirsute.

Described from one ♀: Chilangali.

Total length.	Pronotum.	Elytra.	Posterior femora.	Posterior tibiae.
mm.	mm.	mm.	mm.	mm.
32	7	26	15	11·5

Acorypha (*Caloptenopsis*) *pallidicornis,* Stål.

Kilosa; Nyegezi.

Acorypha (*Caloptenopsis*) *mossambicus,* Brancs.

Kilosa; Tubugwe (Dodoma dist.).

Acrophymus cuspidatus, Karsch. (Plate VI, fig. 10; Plate IX, fig. 41.)

Mlemu (Dodoma dist.).

Oxyaeida brachyptera, sp. n. (Plate VIII, figs. 26, 27; Plate X, fig. 56.)

Antennae pale purplish brown; eyes amber; face light brown; genae and occiput dark green; genae with a pale narrow yellow stripe behind the eyes and along the posterior and inferior margins; lateral lobes of pronotum dark green; disc brownish green; lateral carinae lemon yellow; pleurae dark green; sternites and abdomen light brown; anterior and median legs brownish green; posterior femora (♂) reddish orange, (♀) pale olive green; posterior tibiae (♂) reddish orange, black basally, spines whitish tipped with black; posterior tibiae (♀) pale olive green, black basally and slightly suffused with reddish orange apically, spines as in ♂; posterior tarsi (♂) reddish orange, (♀) purplish; elytra olive green, with vena dividens pale lemon yellow; wings greenish brown.

Antennae filiform, finely punctulate and hirsute, slightly longer than head and pronotum together; eyes large, broadly oval, with the front margin almost straight; interocular distance slightly less than greatest fastigial width; frontal ridge in profile almost straight; face retreating; fastigio-facial angle rather narrowly rounded; from the front, frontal ridge feebly impressed round median ocellus; margins parallel; surface smooth with scattered punctures; fastigium descending slightly; from above, apex broadly rounded; surface

with two foveolae divided by a median carinula; surface of face and occiput loosely punctate, of genae loosely punctate with an irregular diagonal sulcus; median carina of pronotum in profile almost straight; lateral carinae indistinct; anterior and posterior margins of disc very feebly rounded; anterior and posterior margins of lateral lobes almost straight; inferior margins rotundato-angulate, with the apical half feebly concave; transverse sulci distinct; surface of pronotum strongly foveolate punctate with the superior anterior area of the lateral lobes with large foveolae; prosternal spine transverse, apex bilobate, the lobes thick, rounded; abdomen strongly carinate dorsally; supra-anal plate (♂) triangular, narrowly rounded apically, with the surface irregularly depressed and rugose; subgenital plate (♂) conical, narrowly rounded apically, smooth, hirsute; supra-anal plate (♀) triangular, strongly compressed laterally and with a median basal depression; subgenital plate (♀) quadrate, with a strong median apical projection, an apical projection laterally and a depression apically laterally; cerci (♂) simple, hirsute, somewhat laterally compressed basally and incurving strongly; cerci (♀) simple, rather short; upper and lower ovipositor valves feebly serrate; elytra (♂) barely exceeding the base of the posterior femora; (♀) reaching to about a quarter of the length of the posterior femora, which exceed the apex of the abdomen by about a fifth of their length in the ♂ and barely exceed the apex of the abdomen in the ♀.

Differs from *O. carli*, Bol., by much shorter elytra.
Described from one ♂ (type) and one ♀: Kilosa.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	21	4·5	6	13
♀	31·5	6·5	9·5	18

Bibulus brunni, Gig. Tos.

Dar-es-Salaam; Uluguru Mts.; Kissaki; Kilosa; Tindiga; Mkalama.

Tylotropidius speciosus, Walk.

Bukene.

Tylotropidius gracilipes, Brancs.

Kilosa; Tubugwe (Dodoma dist.); Kalula; Kizumbi; Nyegezi; Bukene; Myombo; Korogwe.

Tylotropidius, sp.

Five ♀'s: Bukene. Two ♀'s: Kilosa.

Cataloipus oberthüri, Bol.

Kitope (Dodoma dist.); Mtugutu (Dodoma dist.); Dar-es-Salaam; Uluguru Mts.; Kilosa; Tindiga; Korogwe.

Cataloipidius roseus, Bol.

Two ♂'s: Kalula.

Thisoicetrus coerulipes, Sjöst.

Tindiga; Segoma.

Euprepocnemis ibandana, Gig. Tos.

Tindiga; Kimamba; Uluguru Mts.; Chilangali; Kilosa; Kalula.

Euprepocnemis capitatus, sp. n. (Plate IX, fig. 36.)

Antennae light stramineous; eyes light brown, with dark brown narrow longitudinal bands; head pale pinkish brown, with scattered brown spots on the face and clypeus and with a narrow dark-brown band along the anterior margin of the genae below the eyes; pronotum light stramineous with a dark-brown fusiform marking covering practically the whole of the disc and strongly narrowed behind; pleurae, sternites, anterior and median legs light stramineous; femora of posterior legs light stramineous, irregularly and faintly dotted with dark brown on the superior faces and with a greyish suffusion on the oblique ridges; posterior tibiae bluish, becoming purple towards apices, with irregular whitish fasciae at the base, and black at the condyle; spines yellowish with black tips; elytra smoky stramineous, with irregular brownish areolets in the discoidal and apical areas, and a narrow pale cream fascia near the base of the mediastinal area; wings hyaline; abdomen light brown.

Antennae filiform, surface finely punctate; (♂) one and a tenth as long, (♀) subequal to head and pronotum together; head large; eyes broadly oval with the front margin almost straight, subequal to infra-ocular portion of the genae in length; interocular distance equal to width of frontal ridge between antennae; fastigio-facial angle broadly rounded; fastigium from above rotundato-truncate apically, with the lateral margins almost straight; surface with a feeble pyriform impression, and a median longitudinal carinula; frontal ridge from the front smooth with scattered punctures; margins slightly divergent from the vertex to the clypeus and somewhat indistinct near clypeus; in profile almost straight; surface of face and inferior area of genae smooth, with scattered punctures; remainder of head smooth; anterior margin of pronotal disc straight; posterior margin broadly rotundato-angulate; anterior and posterior margins of lateral lobes almost straight; inferior margins obtuse angulate; lateral carinae of disc distinct and straight on prozona; median carina distinct and very feebly sinuate; pronotum strongly constricted laterally between the metazona and prozona; superior area of prozona of lateral lobes strongly impressed; surface of pronotum and pleurae rugulose punctuate; prosternal spine subquadrate, slightly inclined backwards, rotundato-truncate apically and with a feeble impression apically; supra-anal plate (♂) pentagonal, with the apical angle rounded, strongly depressed laterally and medio-basally; subgenital plate (♂) conical, with the apex rounded and with a deep median basal depression; supra-anal plate (♀) triangular, with the apex rounded, the lateral margins feebly sinuate, constricted laterally basally and with a broad median basal sulcus; subgenital plate (♀) quadrate with the apical margin strongly emarginate; cerci (♂) slender, curving inwards feebly, strongly compressed basally and feebly compressed apically; elytra narrowly rounded apically; (♂) slightly exceeding the apex of the abdomen in length; (♀) reaching to the base of the ovipositor valves; wings subequal to elytra in length; femora of median legs with longitudinal sulci; femora of posterior legs with a feeble serration on the superior median carina.

Described from seven ♂'s (including the type) and sixteen ♀'s : Nyegezi.

	Total length. mm.	Pronotum. mm.	Elytra. mm.	Posterior femora. mm.
♂	26	5	18	16·5
♀	38	7	26	23

Explanation of Plates V–XI.

Plate V.

Fig. 1. *Kraussaria dius*, Karsch. ♀. Side view.
2. *Panzia uvarovi*, gen. nov. et sp. n. ♂. From above.
3. *Ornithacris cyanea cyanea*, Stoll. ♀. Elytron and wing.
4. *Cardenius formosus*, sp. n. ♀. Side view.
4a. „ „ „ ♂. Head and pronotum from above.
5. *Catantops viridipunctatus*, sp. n. ♂. From above.
6. *Pycnodictya kilosana*, sp. n. ♀. Elytron and wing.
7. *Homoxyrrhepes punctipennis*, Walk. ♀. Side view.

Plate VI.

Fig. 8. *Tmetonota dispar*, sp. n. ♀. Side view.
9. „ „ „ ♂. „ „
10. *Acrophymus cuspidatus*, Karsch. ♂. Side view.
11. *Plagiotriptus hippiscus*, Gerst. ♀. „ „

Plate VII.

Fig. 12. *Metapa usambarica*, Karsch. ♀. Side view.
13. „ „ „ ♂. „ „
14. *Maura modesta*, Bol. ♀. Side view.
15. *Pycnodictya kilosana*, sp. n. ♀. Head and pronotum from above.
16. *Parepistaurus deses*, Karsch. ♂. Side view.

Plate VIII.

Fig. 17. *Sumba nigrescens*, sp. n. ♂. Head and pronotum, side view.
18. „ „ „ „ „ „ „ from above.
19. *Tmetonota dispar*, sp. n. ♀. Head from front.
20. *Ixalidium obscuripes*, sp. n. ♂. Side view.
21. „ „ „ „ Apex of abdomen from above.
22. *Catantops curvicercus*, „ „ Side view.
23. „ „ „ „ Apex of abdomen from above.
24. „ „ „ „ Cercus.
25. *Catantops viridipunctatus*, sp. n. ♂. Cercus.
26. *Oxyaeida brachyptera*, sp. n. ♂. Side view.
27. „ „ „ „ Apex of abdomen from above.
28. *Tanita dispar*, sp. n. ♂. Head and pronotum from above.
29. „ „ „ ♀. „ „ „ „
30. *Orthochtha dimorpha*, sp. n. ♂. Apex of abdomen from above.
31. *Eupropacris obscura*, sp. n. ♂. Apex of abdomen from above.
32. „ *abbreviata*, sp. n. ♂. Apex of abdomen from above.

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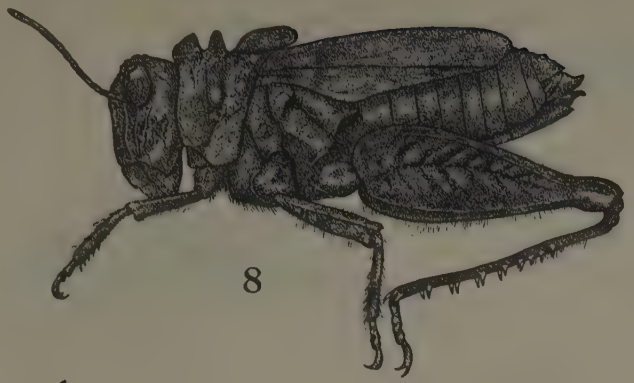

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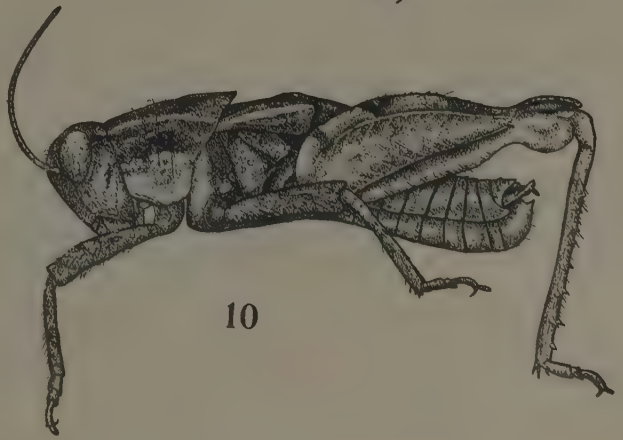

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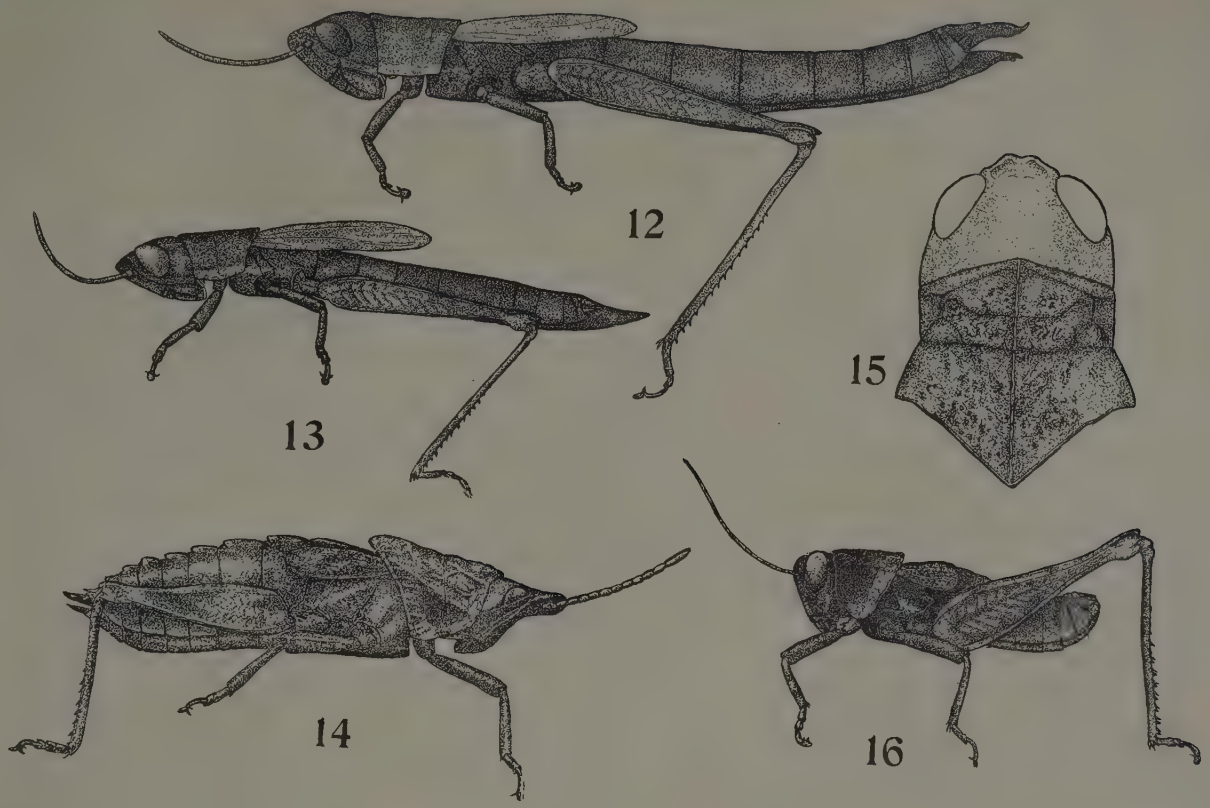

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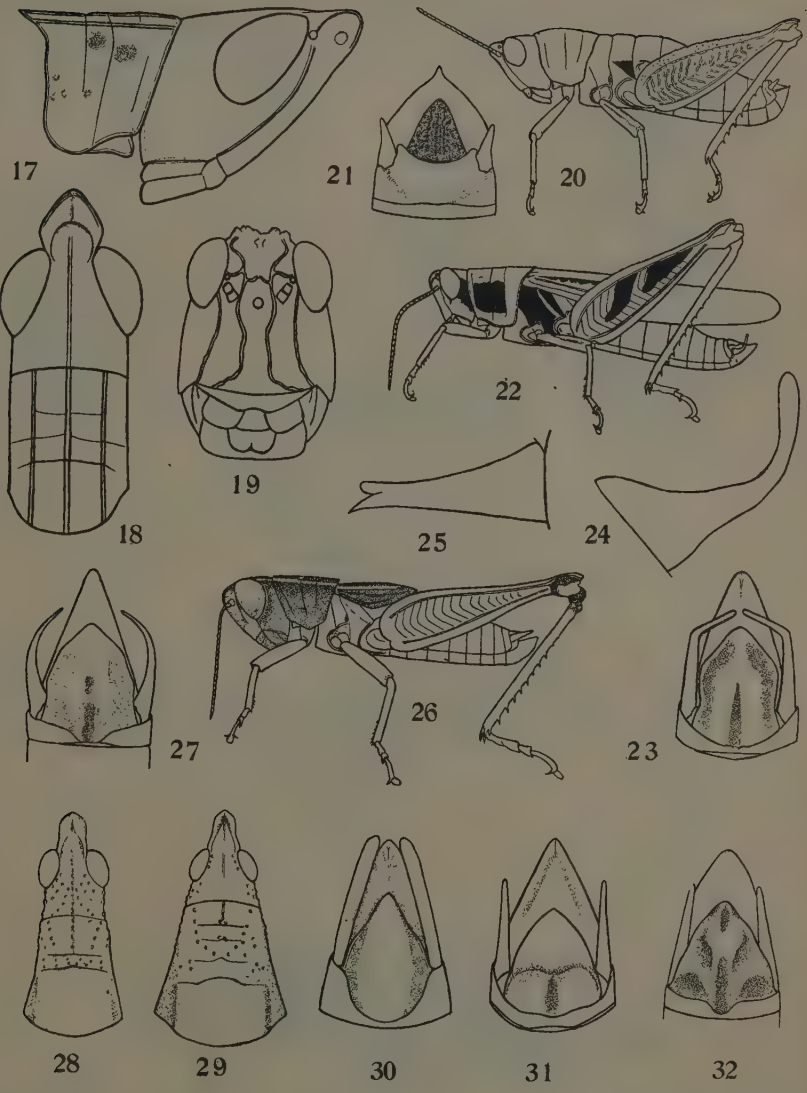

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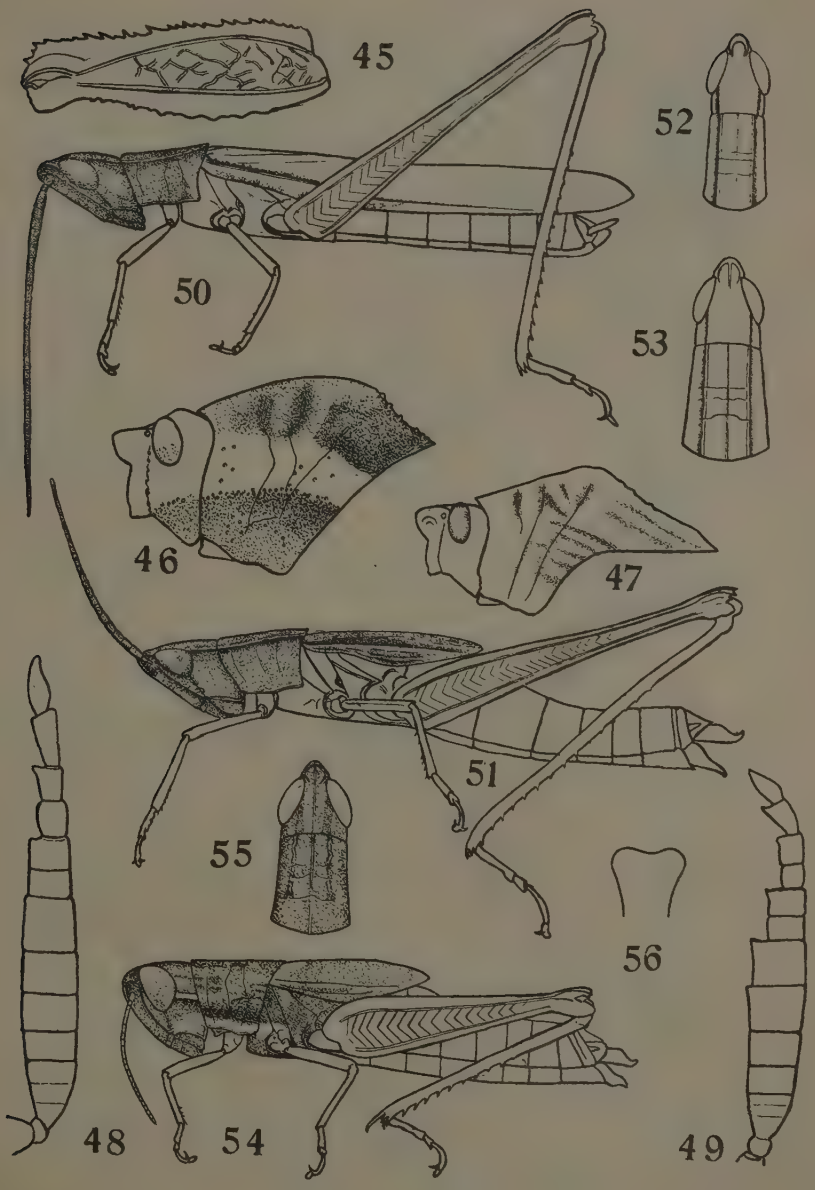

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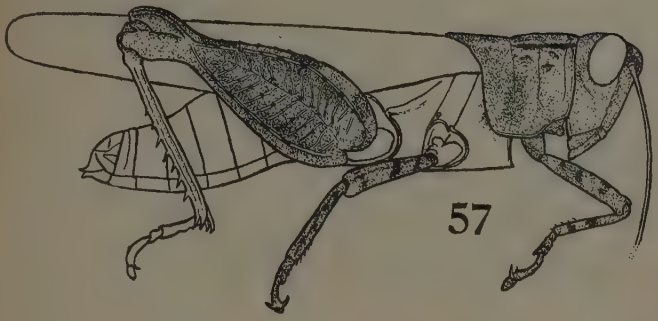

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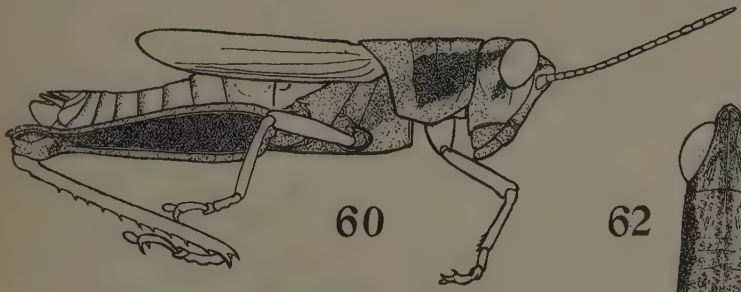

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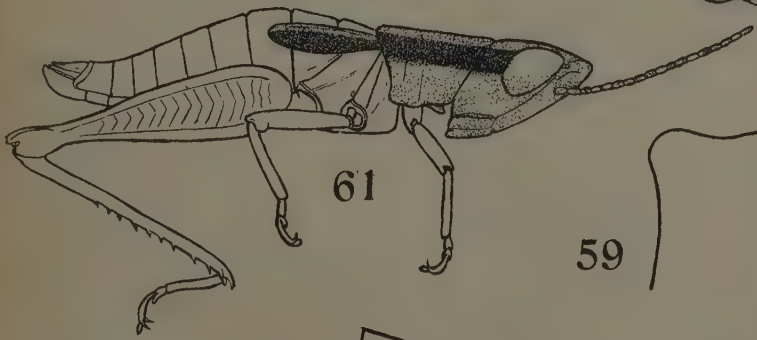

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ACRIDIDAE OF TANGANYIKA TERRITORY.

Plate IX.

Fig. 33. *Oedaleus dilutus*, sp. n. ♂. From above.
34. *Conipoda gracilis*, „ „ Head and pronotum, side view.
35. „ „ „ „ „ „ „ from above.
36. *Euprepocnemis capitatus*, sp. n. ♂. Head and pronotum from above.
37. *Acridoderes crassus*, Bol. *aequalis*, subsp. n. ♂. Head and pronotum from above.
38. *Ornithacris cyanea cyanea*, Stoll. ♀. Pronotum, side view.
39. *Panzia uvarovi*, gen. nov. et sp. n. ♂. Head and pronotum, side view.
40. „ „ „ „ „ „ „ Elytron and wing.
41. *Acrophymus cuspidatus*, Karsch. ♂. Apex of abdomen from above.
42. *Zacompsa brevipennis*, sp. n. ♀. Side view.
43. *Catantops hemipterus*, „ „ „ „
44. *Aulacobothrus subsinuatus*, sp. n. ♂. Head and pronotum from above.

Plate X.

Fig. 45. *Lamarckiana kilosana*, sp. n. ♂. Posterior femur.
46. „ „ „ ♀. Head and pronotum, side view.
47. „ „ „ ♂. „ „ „ „ „
48. „ „ „ ♀. Left antenna.
49. „ „ „ ♂. „ „
50. *Orthochtha dimorpha*, sp. n. ♂. Side view.
51. „ „ „ ♀. „ „
52. „ „ „ ♂. Head and pronotum from above.
53. „ „ „ ♀. „ „ „ „ „
54. *Aulacobothrus brevipennis*, sp. n. ♀. Side view.
55. „ „ „ „ Head and pronotum from above.
56. *Oxyaeida brachyptera*, sp. n. ♂. Prosternal tubercle.

Plate XI.

Fig. 57. *Stenocrobylus crassus*, sp. n. ♀. Side view.
58. „ „ „ „ Head and pronotum from above.
59. „ „ „ „ Prosternal tubercle.
60. *Eupropacris abbreviata*, sp. n. ♂. Side view.
61. *Spathosternum pedestris*, „ „ „ „
62. „ „ „ „ Head and pronotum from above.
63. *Anthermus acutifrons*, sp. n. ♂. Head and pronotum, side view.
64. „ „ „ „ Cercus.

A REVISION OF THE INDO-AUSTRALIAN AND ETHIOPIAN SPECIES OF THE GENUS *MICROGASTER* (HYM. BRACON.)

By D. S. Wilkinson.
(Senior Assistant, Imperial Bureau of Entomology.)

[Read May 1st, 1929.]

With Seven Text-figures.

Introduction.

After I had published my papers on the Indo-Malayan species of *Microgaster* (*Bull. Ent. Research*, xviii, 1927) and the Indo-Australian species of *Apanteles* (*ibid.*, xix, 1928), I commenced work on the Ethiopian species of the Microgasterinae. It soon became obvious to me, however, that revisions in this sub-family would not be really satisfactory if they were separated to deal only with species from their own limited region, and I immediately decided to write for each genus a paper to include all species from Africa and Indo-Australia. The following paper therefore deals with *Microgaster*, and it is hoped very shortly to publish papers of a similar nature both for *Microplitis* and *Apanteles*, the key for the latter having already been prepared.

The interesting structure on the sheaths of the ovipositor, referred to in the text as the " process," has been figured for every species in which I have found it to occur. As far as I am aware such a process, although known in other families of the Hymenoptera, has not previously been seen in the Braconidae, and, therefore, it will undoubtedly be suggested that the species exhibiting this character should be separated off as a subgenus, or even as a new genus; personally, however, I consider, at least at the moment, that such a proceeding is unnecessary and certainly premature.

The particular nomenclature in this paper is the same as that employed in my paper on the Indo-Malayan *Apanteles*.

I am much indebted to Drs. J. Waterston, A. B. Gahan, and C. F. W. Muesebeck for certain kind assistance that I have received at their hands, and to the authorities of the Hungarian National Museum, the Transvaal Museum, the United States National Museum, and the Zoological Museum, Berlin, for permitting to be sent to me various types for examination; also I have to thank Mr. Terzi for the really fine drawings of the ovipositors and sheaths that he has prepared.

Key to the Species.

1. The three basal tergites considerably more strongly chitinised than the remainder, and apparently not flexible; 2nd suture deep and strongly crenulate; the apex of the 3rd tergite, which is the broadest point of the tergum, roundly truncate, beyond which the remaining tergites extend only for a short distance; 3rd tergite with strong longitudinal carinulae 2.
   The three basal tergites not so describable . . . . . 3.
2. First and second tergites yellow-testaceous . . . . 1. *basimacula*, Cam.
   All tergites black . . . . . 2. *integra*, sp. n.
3. First tergite with the median length definitely considerably greater than the apical breadth . . . . . 4.

First tergite with median length not or hardly greater than the apical breadth . . . . . 19.

4. Propodeon with a strong, often very strong (rarely weak), median longitudinal carina . . . . . 8.
Propodeon without median longitudinal carina . . . . . 5.

5. Second tergite elongate, definitely longer than the greatest breadth of the 1st tergite . . . . . 3. *petiolaris*, Szép.
Second tergite short, the greatest breadth of the 1st tergite as great or even very definitely greater than the length of the 2nd tergite . . . . . 6.

6. The areolet very definitely 4-sided, the 2nd abscissa of the radial equal to or even greater than the 2nd transverse cubital; hind coxae and hind femora black . . . . . 4. *tegularis*, Szép.
The areolet 3-sided or nearly so, at the most with the 2nd abscissa of the radial punctiform and less than half the length of the 2nd transverse cubital; hind coxae and hind femora bright red testaceous . . . . 7.

7. Mesonotum red testaceous; ovipositor sheaths considerably longer than the hind tibiae . . . . . 5. *resplendens*, sp. n.
Mesonotum black; ovipositor sheaths considerably shorter than the hind femora . . . . . 6. *morata*, sp. n.

8. Mesonotum red . . . . . 9.
Mesonotum black . . . . . 13.

9. Thorax wholly red testaceous . . . . . 10.
Thorax not wholly red testaceous . . . . . 12.

10. Head black . . . . . 7. *tearae*, sp. n.
Head red testaceous . . . . . 11.

11. Breadth of stigma greater than length of 1st abscissa of radial; apical half of abdomen black . . . . . 8. *rixosa*, sp. n.
Breadth of stigma less than length of 1st abscissa of radial; apical half of abdomen red testaceous . . . . . 9. *apo*, sp. n.

12. Hind coxae black; ♀ with the distance between a posterior ocellus and the eye as great as or greater than the diameter of an ocellus; areolet virtually 4-sided . . . . . 10. *vulpina*, sp. n.
Hind coxae yellowish testaceous; ♀ with the distance between a posterior ocellus and the eye less than the diameter of an ocellus; areolet 3-sided 11. *indica*, Wilkn.
Hind coxae red testaceous; ♀ with the distance between a posterior ocellus and the eye greater than the diameter of an ocellus; areolet 4-sided . . . . . 12. *bicolor*, Szép.

13. The four anterior coxae and the greater part of the hind femora * testaceous or red testaceous . . . . . 14.
All coxae and the hind femora * strongly darkened to black . . . . 16.

14. Hind coxae above strongly punctate . . . . . 13. *perniciosa*, sp. n.
Hind coxae above impunctate, smooth, at least not strongly punctate . . 15.

15. Apical half of 1st tergite darkened, smooth; areolet virtually 4-sided, the 2nd abscissa of radial being punctiform . . . . 14. *eurygaster*, Cam.
Apical half of 1st tergite not darkened (tergite unicolorous throughout), coarsely punctate at apex; areolet definitely 3-sided. . 15. *psarae*, Wilkn.

16. Areolet 4-sided, the 2nd abscissa of the radial at least punctiform; the four posterior femora, the four posterior tibiae, and the hind tarsi, completely darkened . . . . . 16. *turneri*, sp. n.
Areolet definitely 3-sided, the 2nd abscissa of the radial definitely absent, the 2nd transverse cubital being received into the 1st transverse cubital at about its centre . . . . . 17.

17. Wings strongly infumated only at apex; ovipositor sheaths with process; cocoons in a gregarious mass . . . . . 18.

* The ♂♂ of *persimilis* have the hind femora red testaceous.

Wings at least bifasciated, the fasciae often so broad that most of the wing is strongly infumated; ovipositor sheaths without process; cocoons solitary . . . . . 17. *earina*, sp. n.

18. Middle femora of ♀ darkened; ovipositor sheaths not tapering, four times as long as process . . . . . 18. *fascipennis*, Gahn.
Middle femora of ♀ red testaceous, not darkened; ovipositor sheaths tapering, six times as long as process . . . . 19. *persimilis*, sp. n.

19. Head rugose, rugoso-reticulate, or rugoso-striate, throughout; mesonotum closely and very strongly punctate, almost rugoso-punctate; disc of scutellum apparently rugose . . . . . 20. *detracta*, Walk.
Head not so describable; mesonotum never closely and strongly punctate, at the most only strongly punctate; disc of scutellum never rugose . . 20.

20. Antennae of ♀ very short and stout (as in *Apanteles flavipes*, Cam.); mesonotum with strong but very definitely separated punctures (degree 4–5); 2nd tergite with median sulci that converge towards apex 21. *austrina*, sp. n.
Antennae normal; mesonotum only with minute punctation; 2nd tergite without median sulci . . . . . 21.

21. Hind femora red testaceous . . . . . 22.
Hind femora strongly darkened to black . . . . . 23.

22. Coxae black; ovipositor sheaths shorter than the hind coxae; 2nd tergite longitudinally striate . . . . . [*novicia*, Mshl.]
Coxae, at least at apex, yellow testaceous; ovipositor sheaths rather longer than hind coxae; 2nd tergite smooth with some indefinite punctation 22. *tjibodas*, Wilkn.

23. Median longitudinal carina of propodeon only very weakly indicated; wings somewhat infumated at apex . . . . . [*polita*, Mshl.]
Median longitudinal carina of propodeon very strong; wings strongly infumated throughout or strongly fasciated . . . . . 24.

24. Thorax bright red testaceous; wings strongly infumated throughout 23. *magnifica*, sp. n.
Thorax black; wings bifasciated . . . . . 24. *kuchingensis*, Wilkn.

1. **Microgaster basimacula,** Cam.

Apanteles basimacula, Cameron, Rec. Albany Mus., i, part 3, 1904, p. 173.

♀. Black; middle coxae, extreme apices of hind coxae, an annulus in the basal third of the hind tibiae, hind tibial spurs, 1st and 2nd abdominal segments, white to extremely pale yellowish testaceous; the four anterior tibiae and tarsi, all trochanters and trochantines, red but often strongly darkened; antennae light red, darkening towards apex; stigma and most wing-veins brown, the costal veins basally testaceous; wings hyaline, the fore-wing strongly infumated in the apical third of the radial, in the apical half of the 3rd cubital, and in the apical third of the 2nd discoidal cells, and the hind-wing slightly infumated at extreme apex.

♂. Black; a broad annulus in the basal half of the hind tibiae, hind tibial spurs, 1st and 2nd abdominal segments, white to extremely pale yellowish testaceous; the four anterior legs, hind trochanters and tibiae, red but often strongly darkened to black, particularly the coxae; antennae dark brown to black evenly throughout; stigma and most wing-veins brown; wings very faintly infumated more or less throughout.

♀♂. *Head* striate and aciculate, with punctation; clypeus more or less differentiated from face; facial depressions nearer to apex of clypeus than to eyes; hind ocelli nearer to the eyes than to each other. *Thorax:* mesonotum and disc of scutellum with strong, close punctation, the area between the punctures commonly minutely aciculate; the scutellar sulcus straight and strongly crenulate; the mesopleural sulcus elongate, broad,

and rather shallow, not sculptured more strongly than the remainder of the mesopleurae which is much as the mesonotum except for a smooth shining area extending from above the sulcus to the upper posterior margin; propodeon punctate as the mesonotum or possibly rather more closely, with a strong median longitudinal carina which is crenulate down the sides. *Wings* with venation not altogether invariable; the 1st transverse cubital, the 1st abscissa of the radial, and the breadth of the stigma, all about equal, 1·25 times as long as the recurrent, which latter is usually 1·25 times as long both as the apical portion of the 1st abscissa of the cubital and as the combined lengths of the 2nd and pigmented portion of the 3rd abscissa of the cubital; stigma equal to or rather shorter than metacarp; the more or less sinuate 1st transverse cubital receives the unpigmented 2nd transverse cubital somewhat above its middle, and joins with the more or less sinuate 1st abscissa of the

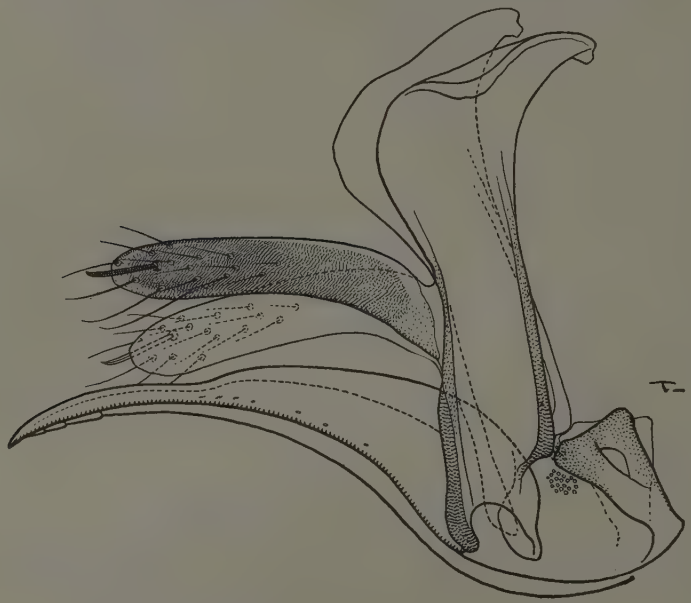

Fig. 1.—*Microgaster basimacula*, Cam., ovipositor and sheaths.

radial at right angles, with a stump at their point of junction. *Legs:* hind coxae on outer faces and above punctate more or less as the mesonotum or more strongly, on inner faces with decidedly more widely spaced and rather obscure punctation; hind femora with obscure rugose punctation; the longer hind tibial spur five-sevenths, and the shorter spur three-sevenths, the length of the basal joint of the hind tarsus. *Abdomen:* 1st tergite with median length about equal to apical breadth, and twice as long as basal breadth, with the lateral sides straight, and with a strong median longitudinal excavation which bifurcates shortly before joining the crenulate apical margin, the tergite thus divided into two portions, the lateral apical angles of each portion rounded, the inner angles more strongly rounded than the outer; 1st suture apparently more or less flexible; 2nd tergite with apical breadth 1·16 times as great as basal breadth, 1·4 times as great as lateral length, and 1·56 times as great as median length, each lateral basal angle rounded by a crenulate sulcus, each of these sulci at the base of the tergite towards the middle joining a straight, crenulate, longi-

tudinal sulcus which runs down either side of a smooth, median, longitudinal, more or less parallel-sided area and joins the strongly emarginate apex of the tergite; the 1st and 2nd tergites are rugosely reticulate; the 2nd and 3rd tergites connate, with the suture strongly crenulate; 3rd tergite with a broad, smooth, median, longitudinal area extending from the base to apex as in the 2nd tergite, only broader, otherwise with strong longitudinal carinae throughout its length, with the intermediate areas often strongly punctate, with the apical breadth (which is the broadest point of the tergum) 1·14 times as great as basal breadth, 1·6 times as great as median length, which latter (since the apical lateral angles are rounded and since the 2nd tergite is so strongly emarginate) is 1·47 times as long as the lateral margins; 4th and succeeding tergites normal, unsculptured, almost hidden by the almost carapaceiform condition of the three basal tergites; ovipositor sheaths (fig. 1) with process.

Length 4 mm.

Redescribed from 2 ♂♂ which agree absolutely and which are both labelled as "type" in Cameron's writing; 1 ♂, kindly lent me by the South African Museum, Cape Town, labelled by Cameron, but not as "type"; 1 ♂ in the British Museum labelled by Cameron, in obvious error, as "*Apanteles capensis*, Cam., type, Cape Town," with a further label, not in his writing, "Stellenbosch." South Africa: 3 ♂♂, 2 ♀♀, Umtata, Transkei, 18.ii—18.iii.1923; 1 ♀, Harrismith, Orange Free State, 1–20.iii.1927; 1 ♂, 1 ♀, Mossel Bay, Cape Province, xii.1921–ii.1922 (*R. E. Turner*).

The type locality is Grahamstown.

Type in the British Museum.

Host unknown.

Cocoons unknown.

This extremely interesting species, at present paralleled only by the one that follows next in this paper, would seem to provide many characters on which a new genus could be erected; but, as the present tendency in the Microgasterinae is to sink the numerous genera of Ashmead and others, no good can arise, at least at the moment, from the creation of even a subgeneric name, particularly as Dr. Muesebeck, who kindly examined them, agrees with me that these species are undoubtedly referable to *Microgaster*, despite the unusual form of their three basal tergites.

2. **Microgaster integra,** sp. n.

♂. Black; scape and palpi to a certain extent, the four anterior legs, hind coxae (except basally above and along the upper half of the outer faces), about basal two-thirds to three-fourths of hind femora, basal fourth of hind tibiae, hind tibial spurs, red testaceous; tegulae darkened; flagellum, stigma, and most wing-veins, brown or dark brown; wings slightly infumated evenly throughout.

♂. Agrees with my redescription of *M. basimacula* except as follows:—*Head:* hind ocelli equidistant from the eyes and from each other. *Thorax:* scutellar sulcus weakly crenulate; mesopleural sulcus very shallow; propodeon shining, not strongly punctate, the sculpture and punctation indefinite, and the median carina not strongly crenulate. *Wings:* the breadth of the stigma, the length of the 1st abscissa of the radial and of the 1st transverse cubital, all about equal, rather longer than the recurrent, 1·33 times as long as the apical portion of the 1st abscissa of the cubital, this latter equal to the combined lengths of the 2nd and the pigmented portion of the 3rd abscissae of the cubital; stigma rather shorter than metacarp; the straight 1st transverse cubital receives the unpigmented 2nd transverse cubital somewhat above its middle, and roundly joins with the straight 1st abscissa of the radial at an angle rather greater than 90°, the point of junction without a stump and hard to determine. *Legs:* hind coxae on outer faces and above with very widely spaced, strong, primary punctation, the interspaces with minute secondary puncta-

tion, on the inner faces and below apparently rugose or with obscure rugose punctation, as are the hind femora; the longer hind tibial spur two-thirds, and the shorter spur half, the length of the basal joint of the hind tarsus. *Abdomen:* 1st tergite with median length about 1·26 times as long as apical breadth; 2nd tergite with apical breadth 1·13 times as great as both basal breadth and lateral length, 1·25 times as great as median length; 3rd tergite smooth in apical fifth, with the apical breadth 1·07 times as great as basal breadth, 1·2 times as great as median length, this latter 1·33 times as long as the lateral margins.

Length 3 mm.

AFRICA: Uganda, 1 ♂, vi.1926 (*G. L. R. Hancock*).

Type deposited in the British Museum.

Host unknown.

Cocoons unknown.

3. **Microgaster petiolaris,** Szép.

Microgaster petiolaris, Szépligeti, Ann. Mus. Nat. Hung., iii, 1905, p. 48.

♀. Black; legs (except the tarsi, extreme apices of the hind femora, and of the tibiae, which are slightly darkened, and the hind coxae which for the greater basal part are strongly darkened to black), mouth-parts, tegulae, costal veins, red testaceous; tibial spurs pale; stigma and wing-veins brown; wings slightly and evenly infumated throughout.

♂. Agrees with my redescription of the colour of the ♀ except in the legs, which are as follows:—All coxae strongly darkened; legs otherwise slightly darkened except about basal half to two-thirds of all tibiae, and the anterior femora, which more nearly approach red testaceous.

♀. *Head* minutely punctate; face strongly narrowed below, with the depressions nearer to the eyes than to the apex of the clypeus; posterior ocelli nearer to each other than to the eyes. *Thorax:* mesonotum and disc of scutellum punctate (degree 2); the mesopleural sulcus very broad and shallow, and smooth; propodeon medianly more or less smooth, laterally indefinitely aciculate. *Wings:* breadth of stigma 1·2 times as great as the length of the recurrent, this latter 1·43 times as long as the 1st abscissa of the radial, 1·66 times as long as the 1st transverse cubital; the apical portion of the 1st abscissa of the cubital, the 1st transverse cubital, and the combined lengths of the 2nd abscissa and the pigmented portion of the 3rd abscissa of the cubital, all about equal, the first possibly rather the longest; the upper portion of the basal vein, and the 2nd abscissa of the radial, more or less punctiform, the latter not, or hardly, angled with the hyaline 2nd transverse cubital; stigma as long as metacarp. *Legs:* hind coxae with minute punctation; hind tibial spurs subequal, the longer one-third the length of the basal joint of the hind tarsus. *Abdomen:* 1st tergite impunctate, with numerous fine longitudinal striations, with the median length 1·54 times the greatest breadth (which is at about the middle), this latter 1·22 times the basal breadth and 2·2 times the apical breadth; 2nd tergite to some extent minutely aciculate longitudinally, smooth at base, with median length three times the basal breadth and just greater than the apical breadth of the 2nd tergite, 1·36 times the greatest breadth of the 1st tergite, and equal to the median length of the 3rd tergite; 2nd suture fine; ovipositor sheaths apparently approaching the length of the hind femora, the hypopygium acute.

♂. Agrees with my redescription of the ♀ except as follows:—*Head:* face not strongly narrowed below, with the depressions nearer to the apex of the clypeus than to the eyes. *Wings* as in the ♀ except that the stigma is relatively rather narrower and that the upper portion of the basal vein is rather longer than punctiform. *Legs:* the longer hind tibial spur two-fifths, and the shorter spur three-tenths, the length of the basal joint of the hind tarsus.

Length 3·0–3·5 mm.

Redescribed from Szépligeti's female and male, which I believe are unique specimens.
The type locality was given as Sidney, New South Wales, Australia.
Type in the National Hungarian Museum.
Host unknown.
Cocoons unknown.

This is a species that, almost, might as easily be placed in *Microplitis* as in *Microgaster*, since the mesopleural sulcus is smooth and the longer hind tibial spur is relatively so short. I know of one or two other species, at present fortunately undescribed, that possess such a combination of characters, and I am, more or less, convinced that these two genera will, ultimately, have to be synonymised despite the inconvenience that such a proceeding will entail. Until this is done, however, *Microgaster petiolaris* may definitely be retained in the genus in which it was originally described, since the coxae, although smaller than is usual for this genus, are certainly longer than those of any species that I know that is correctly placed in *Microplitis*. I would add that Szépligeti, in his description, notices the shortness of the spurs, and also that Muesebeck, who kindly examined these two specimens for me, agrees with me in my above remarks with regard to their generic position.

4. **Microgaster tegularis,** Szép.

Microgaster tegularis, Szépligeti, Ann. Mus. Nat. Hung., iii, 1905, p. 49.

♂. Black; mouth-parts, tegulae, the four anterior legs (except basal half of coxae which are darkened), hind trochanters and trochantines, hind tibiae at base, red testaceous; tibial spurs pale; stigma and wing-veins dark brown to black.

The anterior legs show strong traces of darkening, particularly the middle femora beneath.

♂. *Head* with minute (degree 1) and regular punctation; facial depressions nearer to the apex of the clypeus than to the eyes; posterior ocelli rather nearer to each other than to the eyes. *Thorax:* mesonotum, disc of scutellum, mesopleurae, and propodeon, smooth save only for minute punctures; the mesopleural sulcus very broad, very shallow, and entirely smooth. *Wings:* the recurrent, 1st transverse cubital, and 2nd abscissa of cubital, all about equal in length, 1·6 times as long as the apical portion of the 1st abscissa of the cubital, this latter rather shorter than the 1st abscissa of the radial; the breadth of the stigma 2·2 times greater than the length of the apical portion of the 1st abscissa of the cubital, about three times the length of the 2nd abscissa of the radial, this latter about equalling or possibly just longer than the 2nd transverse cubital, but just shorter than the upper portion of the basal vein; the 1st abscissa of the radial and the 2nd abscissa of the cubital very slightly curved, the remainder of the above-mentioned veins straight; stigma shorter than metacarp. *Legs:* hind coxae with close, minute punctation; the hind tibial spurs subequal, the longer about, or rather less than, half the length of the basal joint of the hind tarsus. *Abdomen:* 1st tergite with basal breadth rather less than two-thirds, and with apical breadth about one-fourth, median length, with the sides more or less straight and regularly converging to apex, in basal half shallowly excavate, smooth, and impunctate, in apical half slightly convex and to some extent minutely punctate; 2nd tergite with basal breadth equal to apical breadth of 1st tergite, with a pair of impressed median sulci that extend in a wide, slightly curved, sweep outwards towards, but not quite reaching, the apical angles, the apical breadth of the tergite being about equal to the median length of the 1st tergite but about three times the median length of the 2nd tergite, only minutely punctate as are the succeeding tergites; 3rd tergite longer than 2nd.

Length 3·5 mm.

Redescribed from the type, a male, which, as far as is known, is an unique specimen. The type locality was given as Mt. Victoria, New South Wales, Australia.

Type in the National Hungarian Museum.

Host unknown.

Cocoons unknown.

5. **Microgaster resplendens,** sp. n.

♀. Black; portions of the scape, mouth-parts, clypeus, mesonotum, tegulae, all legs (except hind tibiae in apical half below, and at apex, and hind tarsi), 1st and 2nd tergites, most of the sternum, red testaceous; tibial spurs pale; wing-veins in basal third of wing red testaceous, otherwise brown as is the stigma.

♀. *Head* closely and minutely punctate; facial depressions nearer to the apex of the clypeus than to the eyes; posterior ocelli nearer to each other than to the eyes. *Thorax:* mesonotum minutely punctate; disc of scutellum smooth and highly polished, the crenulate sulcus at its base strongly curved; mesopleural sulcus very broad and very shallow, entirely smooth; propodeon with some aciculation, and at extreme apex medianly with some short longitudinal carinae, otherwise virtually unsculptured, smooth, and shining. *Wings:* the recurrent just shorter than the 1st transverse cubital, longer than the apical portion of the 1st abscissa of the cubital, which latter is longer than the upper portion of the basal vein and equal to the 2nd abscissa of the cubital; the 1st abscissa of the radial very definitely shorter than the breadth of the stigma, 1·5 times as long as the recurrent; 2nd abscissa of the radial punctiform; stigma definitely shorter than metacarp. *Legs:* hind coxae apparently only with some minute punctation; the longer hind tibial spur 0·43 times, and the shorter spur one-third, length of the basal joint of the hind tarsus. *Abdomen:* 1st tergite about 1·5 times as broad at base as at apex, with the sides straight, and with the median length a little more than twice the apical breadth, aciculate in the apical third, otherwise smooth; 2nd tergite with the apical breadth rather less than the median length of the 1st tergite, and with the median length about 0·66 times the basal breadth, this latter being about equal both to the apical breadth of the 1st tergite and the median length of the 3rd tergite, apparently unsculptured, save for strong lateral sulci; succeeding tergites unsculptured; ovipositor sheaths considerably longer than the hind tarsus, about equal to the combined lengths of the hind tibia and the two basal joints of the hind tarsus.

Length 3 mm.

Tasmania: Mt. Wellington, 2,300 ft., 1 ♀, 2–6.iv.1913 (*R. E. Turner*).

Type in the British Museum.

Host unknown.

Cocoons unknown.

6. **Microgaster morata,** sp. n.

♀♂. Black; scape mostly, mouth-parts, tegulae, costal veins, all legs (except the hind tarsi and the apices of the hind tibiae which are very slightly darkened), 1st tergite together with its lateral membranous portion, all pleurites and sternites (except possibly towards apex of abdomen), ovipositor, red testaceous; flagellum opaque brown tinged with red; stigma and most wing-veins red brown.

♀♂. *Head:* face transverse, punctate (degree 2); clypeus differentiated from face, roundly emarginate; facial depressions relatively large, possibly nearer to apex of clypeus than to eyes; ocelli on a slight eminence, the posterior ocelli nearer to each other than to the eyes. *Thorax:* mesonotum and disc of scutellum punctate (degree 3); mesopleural sulcus broad, shallow, and smooth; propodeon medianly in apical two-thirds with a slightly depressed, rugose or rugosely carinate area, otherwise smooth or at the most indefinitely punctate. *Wings:* the breadth of the stigma about 1·2 times as great as the length of the

1st abscissa of the radial, twice as great as the length of the 1st transverse cubital, this latter equal to the recurrent; apical portion of the 1st abscissa equal to the 2nd abscissa of the cubital, longer than the upper portion of the basal vein, three-fourths the length of the recurrent; areolet 3-sided, the hyaline 2nd transverse cubital about half as long as the 2nd abscissa of the radial; stigma shorter than metacarp. *Legs:* hind coxae with only some indefinite punctures; the basal joint of the hind tarsus 1·7 times as long as the subequal hind tibial spurs. *Abdomen:* 1st tergite smooth and shining, the median length twice the apical breadth, this latter rather greater than the basal breadth and a little less than the median breadth; 2nd tergite with a few minute punctures, otherwise smooth, strongly transverse, the apical breadth at least four times the median length, the 2nd suture well marked and slightly sinuate, and the lateral sulci very definitely present; 3rd tergite longer than the 2nd; ovipositor sheaths shorter than hind femora.

Length 3·5 mm.

AUSTRALIA: Victoria, 3 ♀♀, 1 ♂, *undated.*

Type in the British Museum.

Host. Two specimens on one card (the male together with one female) are labelled as parasitic on the Psychid moth, *Thyridopteryx herrichi*, Westw. The host of the other two females, which are pinned, appears to be unrecorded.

Cocoons. The carded specimens have white cocoons.

Cameron labelled the carded specimens *Microgaster henrichi*; but this is, almost undoubtedly, a manuscript name.

7. **Microgaster tearae**, sp. n.

♀. Red testaceous; head (except mouth-parts and clypeus), apical segments of abdomen, black; flagellum, stigma, most wing-veins, apex of hind tibiae, hind tarsi, brown to dark brown; extreme apex of hind femora, hind tibiae, somewhat darkened; wings slightly infumated.

♀. *Head:* face minutely punctate; facial depressions nearer to the apex of the clypeus than to the eyes. *Thorax:* mesonotum and disc of scutellum with strong, well-separated punctation (degree 4), the interspaces smooth and shining; mesopleurae entirely smooth and shining, with the mesopleural sulcus broad and shallow; propodeon smooth and shining, with a well-marked, straight, plain, median, longitudinal carina. *Wings:* the recurrent, apical portion of the 1st abscissa of the cubital, and the 2nd abscissa of the cubital, all about equal, longer than the 1st transverse cubital, this latter longer than the upper portion of the basal vein; the breadth of the stigma 1·25 times as great as the length of the 1st abscissa of the radial, this latter 1·33 times as long as the 1st transverse cubital; the 2nd abscissa of the radial short (but not punctiform), about equal to, and not angled with, the unpigmented 2nd transverse cubital; stigma shorter than metacarp. *Legs:* the longer hind tibial spur three-fifths, and the shorter spur two-fifths, the length of the basal joint of the hind tarsus. *Abdomen:* 1st tergite smooth, with a strong median longitudinal excavation reaching almost to apex, with median length 2·3 times as long as basal breadth and 1·77 times as long as greatest breadth, this latter occurring at a point rather anterior to the base of the apical fourth, beyond which the tergite strongly converges to the narrow truncated apex, the greatest breadth about 2·6 times as broad as the apical breadth; 2nd tergite with the apex arcuately emarginate, smooth and unsculptured except for a widely divergent, short, smooth sulcus at base on each side, and for a smooth, slightly raised, broad, median, longitudinal area; 3rd and succeeding tergites unsculptured; ovipositor sheaths short, apparently without process.

Length 3·3 mm.

AUSTRALIA, 3 ♀♀, *undated.*

Type in the British Museum.

Host. The specimens are labelled as bred from larvae of the Notodontid moth, *Teara tristis*, Lewin.

Cocoons unknown.

One specimen bears a label in Cameron's writing "*Microgaster teiae*, Cam. Type. Victoria"; but I have been unable to trace this species. This particular specimen is also labelled "on moth *Teia tristis*. Vict.", whence Cameron obviously derived his specific name: I am informed, however, that there is no species *tristis* in the genus *Teia*. The other two specimens have the host genus correctly stated.

8. **Microgaster rixosa,** sp. n.

♀♂. Red testaceous; 3rd and succeeding abdominal segments black, the 2nd often strongly darkened; flagellum, stigma, and most wing-veins, dark brown; extreme apices of hind femora, apices of hind tibiae, hind tarsi, to some extent darkened; scape in parts darkened; wings slightly infumated.

♀♂. Agrees well enough with my description of *M. tearae* except as follows:—*Thorax:* mesopleurae indefinitely punctate below and anteriorly. *Wings:* the recurrent about equal to the apical portion of the 1st abscissa of the cubital, longer than the 1st transverse cubital, this latter about equal to the 2nd abscissa of the cubital; breadth of the stigma 1·3 times as great as the length of the 1st abscissa of the radial, this latter 1·66 times as long as the 1st transverse cubital; 2nd abscissa of the radial punctiform, the unpigmented 2nd transverse cubital received at the top of the 1st transverse cubital; stigma rather shorter than metacarp. *Abdomen:* 1st tergite relatively rather broader, not so abruptly narrowed at apex, and with the apex emarginate; 2nd tergite relatively shorter, the median raised area square.

Length 3 mm.

Australia: Moree, New South Wales, 3 ♀♀, 1 ♂, 1918 (*W. W. F.*).

Type in the British Musum.

Host unknown.

Cocoons white, 4 mm. long, and placed loosely together.

9. **Microgaster apo,** sp. n.

♀♂. Red testaceous; flagellum black; stigma, most wing-veins, apex of hind tibiae, hind tarsi, ovipositor sheaths, dark brown; both wings basally infumated, in the fore-wing apically beyond the radial and transverse cubital veins and in the apical three-fourths of the 2nd discoidal and 2nd brachial cells, and in the hind-wing in about apical fourth, strongly infumated.

♀♂. *Head:* face, clypeus, and labrum unusually elongate, minutely punctate; clypeus differentiated from face; facial depressions nearer to eyes than to apex of the clypeus; posterior ocelli nearer to each other than to the eyes. *Thorax:* mesonotum and disc of scutellum very minutely punctate, the latter almost entirely smooth; the scutellar sulcus straight; mesopleurae entirely smooth (except possibly anteriorly and below), the mesopleural sulcus small, punctiform or nearly so; propodeon with strong, median, longitudinal carina, otherwise smooth, impunctate. *Wings:* the 1st abscissa of the radial about 1·5 times as long as the breadth of the stigma, this latter, the length of the apical portion of the 1st abscissa of the cubital, and the recurrent, usually all about equal; the 1st transverse cubital shorter than the recurrent, 1·3 times as long as the 2nd abscissa of the cubital, this latter 1·4 times as long as the upper portion of the basal vein; stigma rather shorter than metacarp; 2nd abscissa of the radial wanting, the unpigmented 2nd transverse cubital received high up in the 1st transverse cubital. *Legs:* hind coxae in upper half smooth

except for some minute scattered punctation; the longer hind tibial spur three-fifths, and the shorter spur less than a third, the length of the basal joint of the hind tarsus. *Abdomen :* 1st tergite smooth and shining, in general shape much like that of *M. psarae*, except that it is relatively narrower and longer and that apically it is considerably more drawn out, so that the breadth of the truncate apex is less than half the greatest breadth; 2nd tergite smooth, in shape much like that of *M. psarae* except that it is relatively longer and that the straight lateral sulci are more strongly marked and are not so widely divergent (angle of divergence from each other about 90°); ovipositor sheaths rather shorter than hind femora, without process.

Length 4·5–5·0 mm.

Philippine Is.: Atimonan, Luzon, 3 ♀♀, 6 ♂♂, 1–31.vii.1908, 1–8.viii.1908, Davao, Mindanao, 1 ♂, 8–13.vi.1910 (*Micholitz*).

Type in the Zoological Museum, Berlin.

Host unknown.

Cocoons unknown.

10. **Microgaster vulpina,** sp. n.

♀♂. Black; head (except ocellar region), scape partly, prothorax, mesonotum, tegulae, the four anterior legs (except the middle coxae), red testaceous; 1st tergite, and the femora, tibiae, and tarsi of the hind legs, commonly strongly reddened; basal pleurites and sternites, the lateral membranous margins of the 1st tergite, hind tibial spurs, pale to white; stigma and most wing-veins red brown.

♀♂. *Head :* ♀ with the distance between a posterior ocellus and the eye greater than the diameter of an ocellus; antennae as long as or longer than the head, thorax, and abdomen together. *Thorax :* mesonotum and disc of scutellum with separated punctures; mesopleural sulcus apparently virtually absent; propodeon entirely smooth and shining except for a rather weak, median, longitudinal carina. *Wings :* the apical portion of the 1st abscissa of the cubital, the recurrent, and the combined lengths of the 2nd abscissa of the cubital and the pigmented portion of the 3rd abscissa of the cubital, all about equal, shorter than the 1st abscissa of the radial, 1·33 times as long as the 1st transverse cubital, this latter longer than the upper portion of the basal vein; the breadth of the stigma in the ♀ 1·66 times and in the ♂ 1·55 times as great as the length of the 1st abscissa of the radial; the 2nd abscissa of the radial small but hardly punctiform, equal to and slightly angled with the unpigmented 2nd transverse cubital; stigma in the ♀ equal to, and in the ♂ rather longer than, metacarp. *Legs :* the longer hind tibial spur rather greater than two-thirds, and the shorter spur half, the length of the basal joint of the hind tarsus. *Abdomen :* 1st tergite punctate in apical fourth, otherwise smooth, both with a median longitudinal excavation as, and shaped as, in *M. tearae* except that possibly the tergite is more rounded round the apical fourth, and that in the ♂ it is relatively somewhat broader; 2nd tergite with breadth about twice median length, with the lateral sides more or less parallel and the apex straight, with obscure, widely separated punctures, and with a pair of short, fine, widely divergent (150°) sulci basally, and medianly with indications of a broad, smooth, longitudinal area; 3rd tergite much as the 2nd without the sulci; ovipositor sheaths short, apparently without process.

Length 3 mm.

Australia: Victoria, 1 ♀ (*type*), 1 ♂, *undated.*

Type in the British Museum.

Host unknown.

Cocoons white.

These two specimens with their cocoons are both on the same card, which bears a label in Cameron's writing "*Microgaster tristis*, Cam. Type. Victoria"; I believe this to be a manuscript name.

The card also bears a third *Microgaster* cocoon together with five Chalcid hyperparasites that emerged therefrom. It should be recorded that these Cameron on another label on the same pin has labelled "*Syntomosphryum urocomae*, Cam. Type. Victoria."

11. **Microgaster indica**, Wilkn.

Microgaster indicus, Wilkinson, Bull. Ent. Res., xviii, 1927, p. 172.

The type locality was given as Rahatgaon, Hoshangabad, Central Provinces, India.
Host. Larvae of the Pyralid moth, *Pyrausta machaeralis*, Walk.
Cocoons. Solitary, white or pale cream, and stoutly constructed.

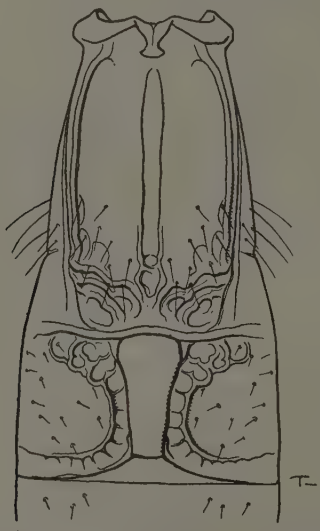

Fig. 2.—*Microgaster indica*, Wilkn., 1st and 2nd tergites.

The sculpture of the 2nd tergite (fig. 2) much as that of *M. bicolor* and of *M. austrina*; ovipositor sheaths (fig. 3) with process.

12. **Microgaster bicolor**, Szép.

Microgaster bicolor, Szépligeti, Wiss. Ergebn. Deutz. Z. Africa Exped., iii, 1911, p. 413.

♀. Red or red testaceous; metanotum and propodeon (except at the sides) black or at least very strongly darkened; flagellum darkening towards apex; stigma and wing-veins red brown, the basal fourth of the former hyaline or with a pale cloud; ovipositor sheaths black.

♀. *Head:* face punctate (degree 2); facial depressions nearer to the apex of the clypeus than to the eye; posterior ocelli equidistant from one another and the eye, the distance between a posterior ocellus and the eye definitely greater than the diameter of an ocellus; antennae short and stout much as in *Apanteles flavipes*, Cam. *Thorax:* mesonotum indefinitely punctate, approaching rugulose, much as in *M. indica* except that it is more

definitely punctate; disc of scutellum smooth, with some very indefinite punctures towards the sides; mesopleural sulcus so broad, shallow, and smooth as virtually to be absent; propodeon with a strong median longitudinal carina which is to some extent crenulate down each side, otherwise more or less smooth, the spiracular carinae present but rather weak. *Wings :* the 1st transverse cubital, the apical portion of the 1st abscissa of the cubital, the combined lengths of the 2nd abscissa of the cubital and the pigmented portion of the 3rd abscissa, equal, longer than the recurrent, in length half the breadth of the stigma which is 1·25 times the length of the 1st abscissa of the radial; the upper portion of the basal vein about one-half the transverse cubital, more than twice the length of the almost punctiform 2nd abscissa of the radial, which latter in length is equal to, but in breadth is considerably greater than, the hyaline, indistinct, 2nd transverse cubital; stigma shorter

Fig. 3.—*Microgaster indica*, Wilkn., ovipositor and sheaths.

than metacarp. *Legs :* hind coxae nearly as long as the combined lengths of the 1st and 2nd tergites, in basal half above with some strong, well-separated punctures (degree 4–5), apically above somewhat aciculate, on outer faces, above smooth and shining, below finely punctate; the longer hind tibial spur about two-thirds, and the shorter spur about half, the length of the basal joint of the hind tarsus. *Abdomen :* 1st tergite longitudinally excavate as in *M. indica*, with the integument apparently unsculptured, nearly twice as long as the greatest breadth, and nearly twice as broad at base as at apex, with the greatest breadth, which is at about the middle, about 2·5 times the apical breadth, the lateral margins (which are nearly parallel) evenly, regularly, and very slightly rounded except in the apical fourth where they are inclined to converge sharply, the apical fourth somewhat turned over and down, and the apex emarginate; 2nd tergite extremely like that of *M. indica* except that the median area is smaller and more convex, and that the curved sulci, although not so well marked, extend further beyond the apex of the median area, and

that the integument is not describable as indefinitely sculptured but rather as smooth; ovipositor sheaths without process, apparently not longer than the basal joint of the hind tarsus.

Length less than 2·5 mm.

Redescribed from the type, a female and I believe an unique specimen.

Type in the Zoological Museum, Berlin.

The type locality is given as Kibwezi, Lake Tanganyika, Tanganyika Territory.

Host unknown.

Cocoons unknown.

13. **Microgaster perniciosa,** sp. n.

♀. Black; mouth-parts, most of scape, the four anterior legs, hind trochanters and trochantines, the basal two-thirds of the hind femora, the basal three-fourths of the hind tibiae (except for a dark annulus at extreme base), the basal pleurites and sternites, the 3rd tergite apically and round the lateral margins to some extent, red testaceous; the hind tibial spurs and the lateral membranous margins of the 1st and 2nd tergites, pale to white; stigma and most wing-veins reddish brown, the former with a pale cloud in basal fourth.

♀. *Head :* face and clypeus with strong, close, shallow punctation, not at all aciculate; clypeus strongly differentiated from face, the facial depressions nearer to the apex of the clypeus than to the eyes; posterior ocelli rather nearer to each other than to the eyes. *Thorax :* mesonotum and disc of scutellum with strong but definitely separated punctation, the latter at apex not margined but with a rugose tumescence; mesopleurae anteriorly and below punctate as the mesonotum, otherwise entirely smooth and shining, with the sulcus smooth and extremely broad and shallow; propodeon strongly, almost rugosely, punctate, with a strong, plain, median, longitudinal carina. *Wings :* the 1st abscissa of the radial, the 1st transverse cubital, the recurrent, the apical portion of the 1st abscissa of the cubital, and the 2nd abscissa of the cubital, all about equal, the latter rather the shorter, rather more than twice as long as the upper portion of the basal vein which is longer than the 2nd transverse cubital; 2nd abscissa of the radial short but not punctiform, angled with and definitely shorter than the 2nd transverse cubital; stigma in length equal to metacarp, in breadth about 1·55 times as great as the length of the recurrent. *Legs :* hind coxae strongly punctate, the punctures basally above very closely placed, on outer faces spaced more widely than on the mesonotum; the longer hind tibial spur three-fifths, and the shorter spur rather less than a half, the length of the basal joint of the hind tarsus. *Abdomen :* 1st tergite in basal half excavate, with apical half slightly turned over and strongly striato-punctate, with a thin, median, longitudinal excavation that hardly extends into the apical third, in general shape much like a broad example of that of *M. turneri*, with the apex slightly emarginate; 2nd tergite with a pair of well-marked, diverging sulci extending in a sweep to about the median point of the lateral margins of the tergite which they join at right angles, with the apex of the tergite arcuately emarginate, the greatest breadth 2·22 times the median length, striate or carinulate except anteriorly to the diverging sulci and laterally; 3rd tergite 1·44 times as long as the 2nd, smooth as are the succeeding tergites; ovipositor sheaths short, without process.

Length 3·5 mm.

Australia : Victoria, 3 ♀♀, *undated* (*C. French*).

Type in the British Museum.

Host unknown.

Cocoons strongly constructed, buff (Oberthur No. 309, tone 1).

14. **Microgaster eurygaster,** Cam.

Apanteles eurygaster, Cameron, Ann. Transv. Mus., ii, 1911, p. 207.

♂. Black; tegulae, costal veins, the four anterior legs, hind femora (except at apices), hind tibiae (except apical fourth), each hind tarsal joint basally, the lateral membranous margins of the basal tergites, red testaceous; scape apparently red brown; basal half of 1st tergite red or red testaceous; stigma, metacarp, and the radial, 1st transverse cubital, and 2nd cubital veins, reddish brown, remaining veins, together with the palpi and hind tibial spurs, pale.

♂. *Head :* face minutely punctate, with a fine median longitudinal carina; facial depressions nearer to the apex of the clypeus than to the eyes; posterior ocelli decidedly nearer to each other than to the eyes. *Thorax :* mesonotum and disc of scutellum with indefinite, minute punctation; mesopleural sulcus punctiform, smooth; the mesopleurae anteriorly punctate as the mesonotum, otherwise for the greater part smooth and shining; propodeon smooth and shining except for a rather weak median longitudinal carina which is weakly crenulate down its sides. *Wings :* the stigma 1·4 times as broad as the length of the 1st abscissa of the radial, which latter is longer than the recurrent and twice as long as the upper portion of the basal vein; the recurrent, 1st transverse cubital, and the combined lengths of the 2nd abscissa and the pigmented portion of the 3rd abscissa of the cubital, all about equal, 1·8 times as long as the apical portion of the 1st abscissa of the cubital, this latter about equal to the upper portion of the basal vein and twice as long as the hyaline 2nd transverse cubital; 2nd abscissa of the radial punctiform; stigma about equal to metacarp. *Legs :* hind coxae apparently with some minute punctation; the longer hind tibial spur rather more than five-eighths, and the shorter spur less than one-third, the length of the basal joint of the hind tarsus. *Abdomen :* 1st tergite highly polished, impunctate, with the basal breadth half the median length and about twice the apical breadth, with the sides parallel (or but slightly converging) to slightly beyond middle, thence definitely and evenly converging to the apparently truncate apex; 2nd tergite apparently unsculptured.

Length 3 mm.

Redescribed from the type, which, as far as is known, is an unique specimen.

The type locality was given as Pretoria, S. Africa.

Type in the Transvaal Museum, S. Africa.

Host unknown.

Cocoons unknown.

The specimen is in bad condition.

15. **Microgaster psarae,** Wilkn.

Microgaster psarae, Wilkinson, Bull. Ent. Res., xviii, 1927, p. 174.

The type locality was given as Kuala Lumpur, Federated Malay States, while cotypes were also taken in Nilambur, Madras, India.

Host. The Malayan series was bred from the Pyralid moth, *Psara bipunctalis,* F., and the Indian series from the Pyralid, *Pilocrocis* (*Pachyzancla*) *aegrotalis,* Zell.

Cocoons pure white, solitary.

16. **Microgaster turneri,** sp. n.

♀. Black; scape, flagellum in basal half more or less, front femora at apex, front tibiae more or less, the four anterior tarsi, red testaceous; apical half of flagellum darkened; the

anterior tibial spurs testaceous; mouth-parts and hind tibial spurs brown; basal pleurites, and the lateral membranous margins of the 1st and to some extent of the 2nd tergite, pale; stigma and most wing-veins brown to dark brown; fore-wings lightly but definitely infumated as follows, otherwise hyaline :—in about the apical third to half of the radial, and apical half of the 3rd cubital, cells; in the upper apical angle of the 2nd discoidal cell; in the lower basal half of the 2nd brachial cell; broadly down each side of the 1st abscissa of the radial vein; narrowly round all veins situated in the neighbourhood of the basal portion of the 2nd abscissa of the medial vein.

♂. Agrees with my description of the colour of the ♀ except as follows :—the four anterior legs (except all four coxae and the front trochanters), hind trochanters, hind femora at extreme base below, bright red testaceous; basal half of hind tibiae, hind tarsi, strongly reddened.

Fig. 4.—*Microgaster turneri*, sp. n., ovipositor and sheaths.

♀♂. Agree well enough with my description of the sculpture of *M. carina*, except as follows :—*Wings :* venation inclined to be variable, particularly in the upper portion of the basal vein and in the apical portion of the 1st abscissa of the cubital, which are commonly rather longer than as hereafter stated; the stigma 1·7 times as broad as the length of the 1st abscissa of the radial, this latter, the 1st transverse cubital, and the recurrent, all about equal; the apical portion of the 1st abscissa of the cubital equal to the 2nd abscissa of the cubital, shorter than the recurrent, 1·5 times as long as the upper portion of the basal vein; the 2nd abscissa of the radial definitely present though punctiform; stigma possibly shorter than metacarp. *Abdomen :* 1st tergite with the median length twice the breadth, the sides being virtually parallel except in apical fourth where they converge roundly to apex, rugose but rather indefinitely, with a strong, median, longitudinal sulcus which reaches almost to the apex of the tergite, and with the apical fourth not or but extremely slightly turned over and down; 2nd tergite with a pair of short, diverging, slightly curved, basal

sulci which may be well-marked or more or less obsolete; ovipositor sheaths (fig. 4) with process.

Length 2·75 mm.

South Africa: Mossel Bay, Cape Province, 6 ♀♀, 2 ♂♂, June and July 1921 (*R. E. Turner*).

Type in the British Museum.

Host unknown.

Cocoons unknown.

17. **Microgaster earina**, sp. n.

♀♂. Black; the greater part of the basal half of the antennae, the four anterior legs (except their coxae), the hind trochanters and trochantines more or less, the extreme base of

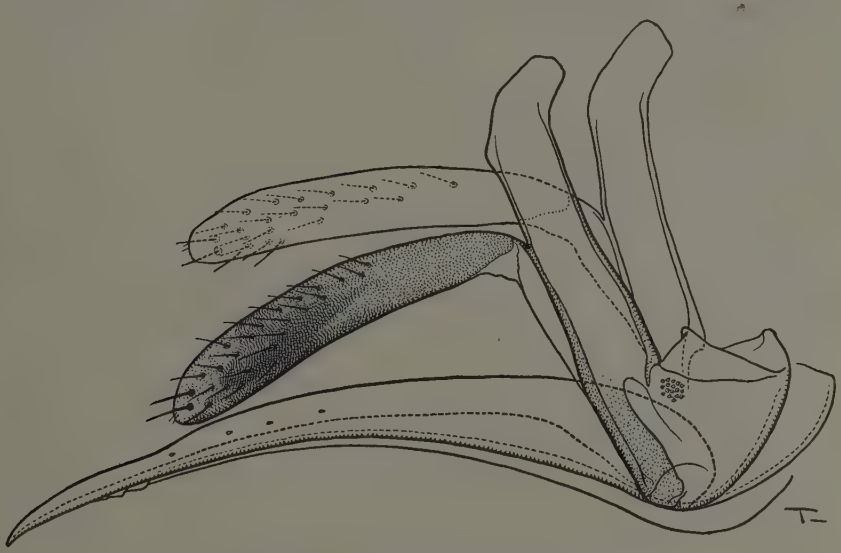

Fig. 5.—*Microgaster earina*, sp. n., ovipositor and sheaths.

the hind femora (particularly below), the basal half of the hind tibiae, red testaceous; mouth-parts and hind tarsi reddened; apical half of antennae dark brown to black; palpi pale; hind tibial spurs white; the basal sternites and the lateral membranous margins of the basal tergites pale reddish testaceous to white; stigma dark brown; most wing-veins brown or dark brown; wings infumated, the infumation variable in strength and extent, often, particularly in the ♂♂, with strong infumation extending uninterruptedly from the basal vein to the apex of the wing, as often, particularly in the ♀♀, bifasciated on account of the basal half of the radial, the middle of the 2nd discoidal, and the apical half of the 2nd brachial cells being hyaline; the basal half of the 3rd cubital cell rarely hyaline; the apical half of the 1st cubital cell invariably infumated; the 2nd discoidal and the 2nd brachial cells almost invariably infumated at their bases; wings of the ♂♂ apparently more deeply infumated and to a greater extent than in the ♀♀.

♀♂. *Head* closely punctate (degree 5), almost rugoso-punctate, commonly striate in addition, often, however, with the punctures more or less obsolete so that the face is more

striate than punctate; facial depressions nearer the apex of the clypeus than to the eyes; posterior ocelli nearer to each other than to the eyes. *Thorax :* mesonotum, and mesopleurae (except above posteriorly), with strong (degree 5), very close, even, almost reticulate or rugose punctation; disc of scutellum strongly margined at apex, sculptured as the mesonotum except that the punctures are somewhat more sparsely placed and that there are strong indications of striae; propodeon with a very strong, median, longitudinal carina which is more or less crenulate narrowly down each side, and with strong, often very deep punctures that vary in number and size, but that are rarely if ever so closely placed as on the mesonotum, and that are often almost describable as obsolete, their interspaces highly shining. *Wings :* venation variable; length of the 1st abscissa of the radial either equal to the breadth of the stigma, in which case it is very definitely longer than the 1st transverse cubital, or about equal to or just a little longer than the 1st transverse cubital, in which case it is very definitely shorter than the breadth of the stigma; apical portion of the 1st abscissa of the cubital equal to the recurrent, shorter than the 1st transverse cubital, about equal to or rather longer than the combined lengths of the 2nd abscissa of the cubital and the punctiform pigmented portion of the 3rd abscissa of the cubital, this combined length longer than the upper portion of the basal vein; the 2nd transverse cubital not pigmented, minute, received into or towards the middle of the 1st transverse cubital, at which point this latter is slightly bent, thus forming two abscissae; stigma shorter than metacarp; the 1st radial, 1st transverse cubital, and 2nd cubital, definitely stronger than the other veins. *Legs :* hind coxae punctate much as the disc of the scutellum; the longer hind tibial spur three-fourths, and the shorter spur about or rather more than half, the length of the basal joint of the hind tarsus. *Abdomen :* 1st tergite with the sides more or less straight, gradually widening to the base of the apical fourth, thence roundly narrowed to the more or less truncated or possibly somewhat emarginate apex, with the median length twice the greatest breadth and about three times the basal breadth, this latter about equal to the apical breadth, with a deeply impressed, broad, smooth, median, longitudinal sulcus extending from the base almost to the apex of the tergite, the basal three-fourths of the tergite otherwise smooth and shining and the apical fourth slightly turned over and down and punctate, the punctures often obscure or even altogether wanting; 2nd tergite with a pair of faintly marked, widely diverging, short, basal sulci, otherwise smooth and polished as are the remaining tergites; ovipositor sheaths (fig. 5) without process, not longer than the basal joint of the hind tarsus.

Length about 3 mm.

Africa : Ibadan, Nigeria, 40 ♀♀, 40 ♂♂, and 4 of sex indeterminable through damage, 22.ii.1924, 12–15.iv.1924, 2.v.1924, 6–18.ix.1924, 5–27.x.1924, 1–30.xi.1924, 4.xii.1924 (type series), 3–11.xii.1924, 2–3.i.1925 (*A. W. J. Pomeroy*).

Type deposited in the British Museum.

Host. Bred from cotton boll-worms, probably *Earias biplaga*, Wlk. This is the species of *Microgaster* referred to by Pomeroy in the 4th Annual Bulletin of the Agricultural Department, Nigeria, 1925, pp. 89–108.

Cocoons solitary, white or very pale buff.

18. **Microgaster fasciipennis**, Gahn.

Microgaster fasciipennis, Gahan, Proc. U.S. Nat. Mus., liv., No. 2252, 1918, p. 587.

♀. Agrees with my description of the colour of *Microgaster carina* except as follows :— apical half of the antennae somewhat, middle femora except at apex, darkened; wings infumated only in about the apical half of the radial, the apical two-thirds of the 3rd cubital, and the apical third of the 2nd discoidal; hind tibial spurs reddened; stigma and wing-veins brown.

♂. Agrees with my redescription of the colour of the ♀ of *M. fasciipennis* except that the middle femora are not at all darkened.

♀♂. Agree with my description of the sculpture of *M. earina* except as follows :— *Wings :* the 1st abscissa of the radial equal to the 1st transverse cubital, shorter than the breadth of the stigma, longer than the recurrent, which latter is equal to the apical portion of the 1st abscissa of the cubital; the combined lengths of the 2nd abscissa and the pigmented portion of the 3rd abscissa of the cubital shorter than the recurrent, about equal to the upper portion of the basal vein; 1st and 2nd transverse cubitals otherwise, and metacarp, as in *M. earina*. *Legs :* hind coxae rather more sparsely punctate than the disc of the scutellum. *Abdomen :* 1st tergite with the sides rather more parallel than in *M. earina*, and with the median length twice the basal breadth and about 1·65 times the greatest breadth; ovipositor sheaths (fig. 6) with process.

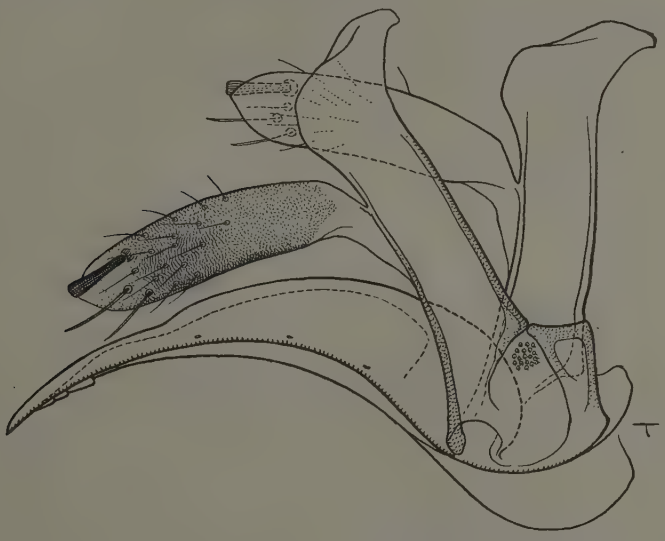

Fig. 6.—*Microgaster fasciipennis*, Gahn., ovipositor and sheaths.

Length, ♀ 3 mm. or rather more, ♂ shorter.

Redescribed from a single ♀ cotype presented by Dr. A. B. Gahan, through the Imperial Bureau of Entomology, to the British Museum, and from 76 ♀♀, 24 ♂♂, received from Mr. Hancock, labelled Kampala, Uganda, 10.viii.1916 (*C. C. Gowdey*).

The type locality was given as Kampala, Uganda, British East Africa.

Type in the United States National Museum.

Host. Recorded as bred from the Hypsid moth, *Deilemera apicalis*, Walk.

Cocoons. Gahan records that the cocoons of this species are pure white and that they are arranged side by side in a compact mass like the cells in a honeycomb.

It would seem to be extremely likely that the type series is but a portion of the above big series of a hundred specimens, and was selected from the latter by Mr. Gowdey for dispatch for identification in the United States : the cotype that we now have in the British Museum is dated 11.viii.1916.

19. **Microgaster persimilis,** sp. n.

♀. Differs from my redescription of *M. fasciipennis* apparently only in the ovipositor and sheaths (fig. 7), in the middle femora, which are not at all darkened, and in the venational characters which are as follows :—the breadth of the stigma and the length of the 1st abscissa of the radial and of the 1st transverse cubital all about equal, that of the latter possibly rather the shorter; the combined lengths of the 2nd abscissa and the pigmented portion of the 3rd abscissa of the cubital about equal to the apical portion of the 1st abscissa of the cubital, this latter possibly just shorter than the recurrent and very

Fig. 7.—*Microgaster persimilis,* sp. n., ovipositor and sheaths.

decidedly shorter (10 : 14) than the 1st transverse cubital; 1st and 2nd transverse cubitals otherwise, and metacarp, much as in *M. carina.*

♂. Differs from the colour of the ♀ only in the hind femora, hind tibiae, and hind tarsi, which are red testaceous except as follows :—femora at extreme apex, tibiae in about apical fourth, and each tarsal joint at extreme apex, very slightly darkened.

Length, ♀ rather more than, and ♂ rather less than, 3 mm.

Africa : Kampala, Uganda, 16 ♀♀, 3 ♂♂, 1925 (*G. L. R. Hancock.*)

Type deposited in the British Museum.

Host unrecorded.

Cocoons. The cocoon masses from which this series was bred agree absolutely with Gahan's description of that of *M. fasciipennis* except that in colour they are very pale buff.

This species is erected primarily on the colour characters and on the differences in the ovipositor and sheaths.

20. **Microgaster detracta,** Walk.

Microgaster detractus, Walker, Ann. Mag. Nat. Hist., (3) v, 1860, p. 308.
Microgaster detractus, Walker, Wilkinson, Bull. Ent. Res., xviii, 1927, p. 171.

The type locality was given as Ceylon.
Host unknown.
Cocoons unknown.

A species immediately recognisable from all others in its group by the strong sculpturing on the head.

21. **Microgaster austrina,** sp. n.

♀. Black; scape, flagellum beneath basally, tegulae, the four anterior legs, about apical half of hind coxae, hind trochanters and hind femora, basal half of hind tibiae, red testaceous; palpi and tibial spurs pale; apical half of hind tibiae, hind tarsi, reddish brown; flagellum, stigma and wing-veins, brown.

♀. *Head:* face transversely striate; facial depressions very definitely nearer to the apex of the clypeus than to the eyes; posterior ocelli rather nearer to one another than to the eyes; antennae short and stout much as in ♀ of *Apanteles flavipes,* Cam. *Thorax:* mesonotum with strong (degree 5), very well separated punctures; disc of scutellum smooth and highly polished; mesopleural sulcus obsolete; propodeon indefinitely sculptured, with a strong median longitudinal carina. *Wings:* the 1st transverse cubital and the 2nd abscissa of the cubital of equal length, just shorter than the recurrent, longer than the apical portion of the 1st abscissa of the cubital, which latter is equal to the upper portion of the basal vein; the 1st abscissa of the radial nearly twice the length of the upper portion of the basal vein, just longer than two-thirds the breadth of the stigma; 2nd abscissa of the radial punctiform; stigma just longer than metacarp. *Legs:* hind coxae above somewhat aciculate, on outer faces in upper half polished and with some well-marked (degree 3–4) but very sparse punctation; the longer hind tibial spur three-quarters, and the shorter spur half, length of the basal joint of the hind tarsus. *Abdomen:* 1st tergite with median length rather less than greatest breadth, about equal to apical breadth, with a fine median longitudinal excavation, in the basal half smooth and shining, the apical third turned over and down and rugoso-punctate; 2nd tergite with median length about one-third apical breadth, with a median area agreeing well enough with the description of that on the 2nd tergite of *M. indica,* Wilkn., except that its sides are slightly curved and that the bounding sulci are rather more strongly marked; 2nd and succeeding tergites otherwise unsculptured; ovipositor sheaths very short.

Length 2·25 mm.

South Africa: Port St. John, Pondoland, 2 ♀♀, 5–30.iv.1923, 1–11.vi.1923 (*R. E. Turner*).

Type in the British Museum.
Host unknown.
Cocoons unknown.

22. **Microgaster tjibodas,** Wilkn.

Microgaster tjibodas, Wilkinson, Bull. Ent. Res., xviii, 1927, p. 177.

The type locality was given as Tjibodas, Java.
Host unknown.
Cocoons unknown.

23. **Microgaster magnifica,** sp. n.

♀. Head, middle coxae largely, middle femora, hind coxae (except for a red streak above), remainder of hind legs (except trochanters which are testaceous), abdomen (except base of 1st tergite), stigma and wing-veins, black or very dark blue-black; mouth-parts (except clypeus), portions of the cheek, thorax, legs except as above, 1st tergite at base, red or red testaceous; tibial spurs pale to white; such strongly chitinised portions of the thorax as the sutures of the metanotum and the carinae of the propodeon are blackish; wings strongly and evenly infumated throughout.

♂. Agrees with the ♀ in colour except that the middle femora are red testaceous and that the flagellum is strongly tinged with red.

♀. *Head :* face weakly striato-punctate; vertex and occiput smooth and shining with only extremely weak punctation (degree 1–2); posterior ocelli hardly further from the eyes than from each other; antennae strong, longer than head, thorax, and abdomen together. *Thorax :* mesonotum, mesopleurae, and disc of scutellum, smooth and shining, with sparse, minute punctation (degree 1); mesopleural sulcus in the form of a single, extremely deep and broad, smooth, puncture; propodeon strongly reticulate, with a very strong median longitudinal carina. *Wings :* the length of the sinuate 1st abscissa of the radial about equal to the breadth of the stigma, rather longer than the apical portion of the 1st abscissa of the cubital; the 2nd abscissa of the cubital half the length of the 1st abscissa of the radial, equal to the upper portion of the basal vein, rather shorter than the recurrent, which latter equals the 1st transverse cubital; the areolet 4-sided, the 2nd abscissa of the radial punctiform; metacarp longer than stigma. *Legs :* hind coxae smooth and shining, with minute punctation; the longer hind tibial spur seven-tenths, and the shorter spur about half, the length of the basal joint of the hind tarsus. *Abdomen :* 1st tergite with the apical breadth, which is the broadest point of the tergite, greater than the median length, in the basal half medianly excavate, very strongly and closely punctate except in the apical quarter which is smooth; 2nd tergite broader than the apex of 1st tergite, hardly broader at apex than at base, with median length rather less than a third of the basal breadth, with a few large punctures towards base, otherwise smooth with minute sparse punctation; 3rd tergite longer than 2nd; ovipositor sheaths about equal to the basal joint of the hind tarsus; hypopygium drawn out to a point.

♂. Agrees with the description of the ♀ except as follows :—*Wings :* the 1st abscissa of the radial and the 1st transverse cubital of equal length, shorter than the apical portion of the 1st abscissa of the cubital, this latter shorter than the breadth of the stigma; the recurrent shorter than the 1st transverse cubital, considerably longer than the 2nd abscissa of the cubital, this latter equal to the upper portion of the basal vein. *Abdomen* : 1st tergite with the apical breadth rather less than the median length; 2nd tergite with the median length about 0·38 times the basal breadth, equal to the median length of the 3rd tergite; the sculpture of the tergites is not so strong as in the ♀.

Length 5 mm.

Australia : Mackay, Queensland, 2 ♀♀, 2 ♂♂, iii.1901.

Type in the British Museum.

Host unknown.

Cocoons unknown.

24. **Microgaster kuchingensis,** Wilkn.

Microgaster kuchingensis, Wilkinson, Bull. Ent. Res., xviii, 1927, p. 176.

India : Dehra Dun, United Provinces, 1 ♀, 1 ♂, 5.ix.1927 (*S. N. Chatterjee*). The type locality is Kuching, Borneo.

Host. The Indian series was bred from larvae of the Pyralid moth, *Pyrausta coclesalis*, Walk., defoliating bamboo. There is no host record for the type series.

Cocoons. The Indian cocoons are pure white, 7 mm. long, and strongly constructed.

The Indian examples are almost entirely devoid of the strong longitudinal carination on the 1st and 2nd tergites.

Species Unknown to the Writer.

Microgaster annulipes, Mot.

Microgaster annulipes, Motchulsky, Bull. Soc. Nat. Mosc. xxxvi, No. 3, 1863, p. 34.
Microgaster annulipes, Motchulsky, Wilkinson, Bull. Ent. Res., xviii, 1927, p. 173.

The type locality was given as Ceylon.

Host unknown.

Cocoons unknown.

The location of the type is unknown.

Microgaster carinicollis, Cam.

Microgaster carinicollis, Cameron, Spol. Zeylan., iii, 1905, p. 81.
Microgaster carinicollis, Cameron, Wilkinson, Bull. Ent. Res., xviii, 1927, p. 173.

The type locality was given as Ceylon.

Host. Bred from the larva of the Lymantriid moth, *Dasychira securis*, Hübn.

Cocoons unknown.

The location of the type is unknown.

Microgaster formosana, Mats.

Microgaster formosanus, Matsumura, Mem. Soc. Ent. Belg., xviii, 1911, p. 149.

The type locality was given as Riukiho, Formosa.

Host. Bred from the Lymantriid moth, *Laelia costalis*, Mats.

Cocoons unknown.

The location of the type is unknown.

This species was described from a single individual, and its sex was not stated.

Microgaster himalayensis, Cam.

Microgaster himalayensis, Cameron, Wien. Ent. Ztg., xxix, 1910, p. 5.
Microgaster himalayensis, Cameron, Wilkinson, Bull. Ent. Res., xviii, 1927, p. 173.

The type locality was given as Darjiling, India.

Host unknown.

Cocoons unknown.

The location of the type is unknown.

Microgaster nigricornis, Mot.

Microgaster nigricornis, Motchulsky, Bull. Soc. Nat. Mosc., xxxvi, No. 3, 1863, p. 35.
Microgaster nigricornis, Motchulsky, Wilkinson, Bull. Ent. Res., xviii, 1927, p. 173.

The type locality was given as Ceylon.

Host unknown.

Cocoons unknown.

The location of the type is unknown.

Species Wrongly Classified.

The following species were originally described in *Microgaster*, but they are not referable to this genus.

Microplitis basalis, Bingh.

Microgaster basalis, Bingham, Trans. Ent. Soc. London, 1906, p. 125.

Type in the Hope Museum, Oxford.

Apanteles carbonaria, Holmg.

Microgaster carbonaria, Holmgren, Eug. Resa, Ins., 1868, p. 433.
Urogaster carbonaria, Holmgren, Roman, Ent. Tidskr., xxxi, 1910, p. 140.

Type in the Naturhistoriska Riksmuseet, Stockholm.

Microplitis perelegans, Bingh.

Microgaster perelegans, Bingham, Trans. Ent. Soc. London, 1906, p. 126.

Type in the Hope Museum, Oxford.

Apanteles recusans, Walk.

Microgaster recusans, Walker, Ann. Mag. Nat. Hist., (3) v, 1860, p. 308.
Apanteles recusans, Walker, Wilkinson, Bull. Ent. Res., xix, 1928, p. 110.

Type in the British Museum.

Apanteles significans, Walk.

Microgaster significans, Walker, Ann. Mag. Nat. Hist., (3) v, 1860, p. 308.
Apanteles significans, Walker, Wilkinson, Bull. Ent. Res., xix, 1928, p. 123.

Type in the British Museum.

Apanteles subductus, Walk.

Microgaster subductus, Walker, Ann. Mag. Nat. Hist., (3) v, 1860, p. 309.
Apanteles subductus, Walker, Wilkinson, Bull. Ent. Res., xix, 1928, p. 137.

Type in the British Museum.

Apanteles taiticus, Holmg.

Microgaster taiticus, Holmgren, Eug. Resa, Ins., 1868, p. 432.
Urogaster taiticus, Holmgren, Roman, Ent. Tidskr., xxxi, 1910, p. 140.

Type in the Naturhistoriska Riksmuseet, Stockholm.

Host List.

Dasychira securis, Hübn.	*M. carinicollis*, Cam.
Deilemera apicalis, Walk.	*M. fasciipennis*, Gahn.
Earias biplaga, Wlk.	*M. earina*, sp. n.
Laelia costalis, Mats.	*M. formosana*, Mats.
Pachyzancla ; see *Pilocrocis*.	
Pilocrocis aegrotalis, Zell.	*M. psarae*, Wilkn.
Psara bipunctalis, F.	*M. psarae*, Wilkn.
Pyrausta coclesalis, Walk.	*M. kuchingensis*, Wilkn.
Pyrausta machaeralis, Walk.	*M. indica*, Wilkn.
Teara tristis, Lewin	*M. tearae*, sp. n.
Thyridopteryx herrichi, Westw.	*M. morata*, sp. n.

Species of Microgaster, Microplitis, and Apanteles mentioned in this Paper.

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A LIST OF ODONATA OF THE STATE OF MATTO GROSSO, BRAZIL

By Cynthia Longfield, F.E.S., F.Z.S.

[Read May 1st, 1929.]

Plate XII.

The following paper comprises records of those species of Odonata collected in the State of Matto Grosso, Brazil, which have appeared in scientific literature, together with those of the specimens contained in the British Museum Collection.

The records from literature are based on collections made by Mr. and Mrs. Herbert H. Smith in 1885–1886; by Mr. Jesse H. Williamson and Captain J. W. Strohm in 1922; and on collections received by Dr. F. Ris in 1911–1912 through the Berlin firm of Zobrys and Wolter, simply bearing the designation "Matto Grosso." The specimens in the British Museum were collected by Mr. Spencer Moore in 1891–1892, by Mr. E. Dukinfield Jones in 1920, and by the author in 1927.

The greater extent of Matto Grosso forms part of the central tableland of Brazil, where the Paraguay River, and many of the important tributaries of the Amazon River, have their origin. A small portion of the S.W. of the State is swampy alluvial land, through which flows the Paraguay River. The highest point in Matto Grosso is estimated at only 3250 feet, but the largest part of the plateau ranges between 1000 and 2000 feet. The State of Matto Grosso is not covered entirely by forests, as its name would indicate; the vegetation in the southern half is largely thick scrub 8 to 10 feet high, with virgin forest along the river banks and in isolated patches of varying extent.

During the months of April, May and June, 1927, the author was collecting between Lat. 14° 30′ and 20° 30′ S. and Long. 52° 45′ and 57° 30′ W. The following were the four principal collecting areas :—

Corumbá and Urucum.

Corumbá, the inland port of Matto Grosso, situated on the Paraguay River, stands on a limestone cliff 500 feet high, with a thick deposit of ferruginous chert stretching for some miles behind the town. The vegetation is dry and scanty. Twenty miles south of Corumbá rises the range of mountains known as Urucum. This is of igneous origin, and is rich in manganese and iron ore, and, excepting the summits, is covered in virgin forest. The highest point is 2300 feet. This range of mountains, together with the limestone shelf of Corumbá, is surrounded on all sides by low alluvial land, often completely inundated, stretching north, east and south for more than 100 miles each way, but only separated on the west by some 30 miles from the forest-clad ranges of the Bolivian frontier.

Cuyabá.

This is the small and very isolated capital of the State. It stands 1000 feet above sea-level on the small Cuyabá River, a tributary of the Paraguay. The soil of the surrounding country is largely composed of broken-down slate, and

the vegetation is of fairly thick scrub, containing many conspicuously flowered trees, but with no forest.

Melguierra.

An isolated cattle farm, at an altitude of 2000 feet, on the edge of the rubber-forest region. The rubber trees (*Hevea braziliensis*) are fairly plentifully scattered through the forest, along the banks of the Rio Amolar, headwaters of the Paraguay. The forest here is of greater extent than further south, but is still surrounded by miles of open scrub-covered country. Here the soil is composed of sandstone. This farm is about 15 miles south of Diamantino, a small mining town situated on Lat. 14° 30′ S., Long. 57° 30′ W.

Burity.

Another farm, 30 miles N.E. of Cuyabá, situated at the edge of a fairly extensive forest region, and standing on another plateau, called the Chapada (Serra da Chapada). This area is composed of pink sandstone superimposed on the older sedimentary rocks of the lower lying plateau of Central Brazil. The Chapada is many miles in extent, with the S.W. side ending in perpendicular cliffs 1000 feet higher than the surrounding country. It forms another watershed for the Amazon and Paraguay Rivers, and varies in height between 2000 and 2370 feet above sea-level.

Mr. H. H. Smith made his collections (now in the Carnegie Museum, Pittsburgh, U.S.A.) in very nearly the same localities, with the exception of those farthest north. He was at Corumbá, collecting mostly on the flooded plains in April and May (presumably 1885); at Cuyabá (no dates given); on the Chapada in May (presumably 1886), and in Nov. and Dec. The locality-label "Cachoeira," indicates the River Cachoeira (or Cachoeirinha of the charts) rising on the Chapada plateau, 15 miles N.E. of the village of Santa Anna do Chapada, and flowing into the river Cuyabá. The country is similar to that round Burity. There is some doubt as to the locality "Cachoeira Cuyabá." Mr. Smith himself, a few years later, could not say where this was, but it may be the village of Cachoeira, south of Cuyabá, and lying a short distance back from the river of that name, on the Sangrador Grande. The further description, in every case, of "flooded campo, Jan. 1886," makes it unlikely that he meant Cuyabá itself, as there is very little land liable to flooding so far north. "Uacaryzal" was a cattle farm, either on the Rio Cuyabá or the Rio Paraguay, Mr. Smith did not remember which. He was there in the month of Feb.

Mr. Spencer Moore (Sp.M.) collected five species of Odonata, now in the British Museum, while botanist to the Matto Grosso Expedition in 1891–92. Two species bear the locality-labels of Santa Cruz, usually called Barra dos Bugres (a shortening of Barra do Rio dos Bugres), in Lat. 15° S. One species was collected at Corumbá, the other two have no special locality.

Mr. E. Dukinfield Jones (E.D.J.) collected at Nivac, about 40 miles south of Miranda, on the North West Railway, in the extreme southern part of the State. His specimens are now in the British Museum.

On the other hand, Mr. J. H. Williamson and Captain Strohm, of the University of Michigan-Williamson Expedition to Brazil, 1922, made their Matto Grosso collection in the north-west corner of the State, on the Madeira-Mamoré Railway. This area is only eighteen days' journey from the mouths of the Amazon River, but is separated from the previously described localities by at least 600 miles of heavily forested, and practically unexplored territory.

Mr. E. B. Williamson has, so far, only published some of the new species of AGRIONIDAE collected by the members of his expedition. These were procured in March and April, 1922, at Abuná (officially Presidente Marques), and at Villa Murtinho, both on the railway above mentioned.

The author wishes to record her very sincere thanks to Mr. D. E. Kimmins, Department of Entomology, British Museum, for the help and guidance give her in preparing this paper. Her thanks are also due to Mr. C. L. Collenette for the nineteen specimens of Odonata included in the following notes, which were taken after her return to England.

In the following list, the author was the collector of the specimens wherever the data are not followed by a name. These specimens, of which one genus and seventeen species were previously unrepresented in the British Museum Collection, have been presented to the Museum.

An * indicates a species not previously recorded from Matto Grosso.

Family LIBELLULIDAE.

*1. *Orthemis ferruginea*, Fabr., 1775.

Very common. Four ♂♂ and two ♀♀, Cuyabá, May 1927. A pair, first seen attached *per coll.*, afterwards separated, and the female started ovipositing, flying slowly over the stream, repeatedly dipping in the tip of the abdomen. She was caught, and a quantity of moist, cream-coloured eggs was easily pressed out. The male was also taken, Melguierra, by stream in virgin forest, 26.v.27.

*2. *Orthemis biolleyi*, Calv., 1906–1907.

One ♂, Melguierra, by stream in virgin forest, 1.vi.27. This dragonfly was repeatedly attacked by the males of the preceding species. Each time it settled on a reed tip, one or more chased it off, although they took no notice of the males of their own species.

3. *Orthemis cultriformis*, Calv., 1899.

One ♂, Melguierra, by stream in virgin forest, 1.vi.27; one ♂, probably from Chapada (Calvert (1)).

4. *Orthemis ambirufa*, Calv., 1909.

One ♂, Chapada (Calvert (2)); ♀ unknown.

5. *Dasythemis venosa*, Burm., 1839.

Thirteen ♂♂ and six ♀♀, Chapada, May and Dec. (Calvert (2)).

*6. *Dasythemis esmeralda*, Ris, 1910.

A pair taken *in cop.*, Melguierra, in virgin forest near river, 2.vi.27.

7. *Diastatops obscura*, Fabr., 1775.

Dr. P. P. Calvert identifies one ♂ from Uacaryzal, collected by H. H. Smith, as the form *tincta* of Rambur, 1842. This form Dr. F. Ris reincludes in the species *obscura* of Fabricius.

8. *Diastatops pullata*, Burm., 1839.

One ♀, Cuyabá, in scrub near town, May 1927. Two ♂♂ and three ♀♀ flew aboard the boat on the Rio São Lourenço, connecting the rivers Paraguay and Cuyabá, May 1927. One female had the vermilion-coloured abdomen of the

male in place of the typical dark red, while the underside of the wings had the violet-blue sheen found on all male specimens but not on typical females. The rest of the colouring was normal. One ♂, Cachoeira, and one ♂, Cachoeira Cuyabá (Calvert (2)).

9. *Zenithoptera americana*, L., 1758.

One damaged ♂, Uacaryzal (Calvert (2)); two ♂♂ and two ♀♀, Nivac (E.D.J.).

10. *Zenithoptera viola*, Ris, 1910.

Twenty-three ♂♂ and eight ♀♀ from " Matto Grosso " (Ris (1)).

*11. *Perithemis domitia*, var. *mooma*, Kirby, 1889.

Four ♂♂ and three ♀♀, Cuyabá, in scrub near town, May 1927.

12. *Perithemis cornelia*, Ris, 1910.

Three ♂♂, " Matto Grosso " (Ris (1)).

13. *Nephepeltia flavifrons*, Karsch, 1889.

One ♂, Cuyabá, and one ♂, Cachoeira (Calvert (2)).

14. *Nephepeltia aequisetis*, Calv., 1909.

Two ♀♀, Cuyabá, in scrub near town, May 1927; eleven ♂♂ and eleven ♀♀, Cuyabá (Calvert (2)); one ♂ and two ♀♀, Cachoeira (Calvert (2)); one ♂ " flooded campos " Jan. (Calvert (2)); one ♀, Chapada (Calvert (2)); three ♂♂ and three ♀♀, Corumbá, April (Calvert (2)).

*15. *Elga leptostyla*, Ris, 1911.

Two ♂♂ and one ♀, Melguierra, in virgin forest near river, May 1927.

*16. *Oligoclada pachystigma*, Karsch, 1890.

One ♂ flew aboard the boat on the Rio Sāo Lourenço, 4.v.27.

17. *Uracis fastigiata*, Burm., 1839.

One ♂, Melguierra, in virgin forest, 24.v.27; one ♂, " Matto Grosso " (Ris (1)).

18. *Uracis imbuta*, Burm., 1839.

Three ♂♂ and three ♀♀, Melguierra, in virgin forest, May 1927. This was a shade-loving species, taken only in the darkest forest, where the insect was difficult to see. Ten ♂♂ and six ♀♀, Chapada (Calvert (2)).

19. *Uracis infumata*, Ramb., 1842.

One ♂, " Matto Grosso " (Ris (1)).

20. *Uracis siemensi*, Kirby, 1897.

Three ♂♂, " Matto Grosso " (Ris (1)).

21. *Uracis ovipositrix*, Calv., 1909.

Two ♀♀, Burity, in virgin forest away from water, June 1927; four ♀♀, Chapada (Calvert (2)).

22. *Anatya guttata*, Erichs., 1848.

One ♀, Cuyabá, 16.v.27; one ♀, Nobres, on the trail from Cuyabá to Dia-

mantino, 21.v.27; one ♀, Burity, 15.vi.27; eight ♂♂ and seven ♀♀, Chapada (Calvert (2)).

23. *Micrathyria eximia*, Kirby, 1897.

One ♂, Cuyabá (Calvert (2)); four ♂♂, Chapada (Calvert (2)); one ♂, Cachoeira (Calvert (2)); one ♂, Santa Cruz, Dec. (Sp.M.).

24. *Micrathyria tibialis*, Kirby, 1897.

One ♂ and one ♀, Uacaryzal (Calvert (2)); one ♂, Cachoeira (Calvert (2)).

25. *Micrathyria spuria*, Selys, 1900.

One ♂, Cachoeira, and one imperfect ♂, Cuyabá, collected by H. H. Smith, were described as *M. macrocercis*, Calv., by Calvert. Ris, however, can see no reason to separate them from *M. spuria*.

26. *Micrathyria ungulata*, Förster, 1907.

Six ♂♂ and two ♀♀, Chapada, May (Calvert (2)). Calvert described these insects under the name of *M. athenais*, Calv., but here again Ris sees no reason to separate them from *M. ungulata*. Förster's *ungulata* was described from a single ♂ from Teresopolis.

27. *Micrathyria longifasciata*, Calv. 1909.

One ♂ and one ♀, Cuyabá, in scrub near town, 16.v.27; one imperfect ♂, Cuyabá, and one imperfect ♀, Corumbá (Calvert (2)). Calvert's type was a single ♂ from Goya, Argentina.

28. *Micrathyria didyma laevigata*, Calv., 1909.

Five ♀♀ (four imperfect), Corumbá, May (Calvert (2)).

*29. *Micrathyria ocellata dentiens*, Calv., 1909.

One ♂, Cuyabá, in scrub near town, May 1927; two ♂♂ taken by C. L. Collenette, Urucum, near water, Nov. 1927.

30. *Erythrodiplax umbrata*, L., 1758.

Common on waste ground and in scrub, but one ♂ taken in virgin forest near water, Melguierra, 24.v.27; one ♂, Corumbá, April 1927; three ♂♂ and two ♀♀, Urucum, April 1927; two ♂♂ and three ♀♀, Cuyabá, May 1927; one ♂, Cachoeira Cuyabá (Calvert (2)); one ♀, Cachoeira (Calvert (2)); one ♂, Chapada (Calvert (1)).

*31. *Erythrodiplax castanea*, Burm., 1839.

Three ♂♂ and one ♀, Melguierra, in virgin forest near river, May 1927; one pair taken *in cop.*, 25.v.27.

*32. *Erythrodiplax ochracea ochracea*, Burm., 1839.

One ♀, Urucum, at edge of virgin forest, 27.iv. 27.

*33. *Erythrodiplax ochracea aequatorialis*, Ris, 1911.

Here we appear to have both the large and the small forms of Ris. Of the large form, one ♂ and one ♀ were taken at Burity, 13.vi.27; measurements—abd., 21 mm.; hind-wing, 25 mm. Of the small form, one ♂ and one ♀ were taken at Cuyabá, in scrub, 19.v.27; two ♂♂ were taken at Melguierra, by small lake in open scrub, 1.vi.27; one ♀ was taken at Burity, 13.vi.27; measurements—abd., 16 mm.; hind-wing, 18–20 mm.

34. *Erythrodiplax connata fusca*, Ramb., 1842.

One ♂, Tombador, Rio Serragem, at 1500 ft., on the trail from Cuyabá to Diamantino, 5.vi.27; twenty-two ♂♂ and one ♀, Chapada (Calvert (2)), referred by Calvert to *E. connata*, form *e*, are placed by Ris under *E. connata fusca*. One imperfect ♂, Nivac (E.D.J.).

35. *Erythrodiplax connata abjecta*, Ramb., 1842.

Three ♂♂ and one ♀, Campo Grande, at 1750 ft., on the North West Railway, in open scrub near river, April 1927; one ♂, Cuyabá, in scrub near town, May 1927; four ♂♂ and two ♀♀, Melguierra, in virgin forest near river, May 1927; one ♀ in the same locality while ovipositing, 1.vi.27. She flew slowly over the water dipping in the tip of her abdomen at frequent intervals and seemingly at random. Thirty-three ♂♂ and ten ♀♀, Chapada, May and Dec. (Calvert (2)), referred by Calvert to *E. connata*, form *b'*, are placed by Ris under *E. connata abjecta*.

*36. *Erythrodiplax erratica*, Erichs., 1848.

One ♂ and one ♀, Cuyabá, in scrub near town; one ♂, Melguierra, in virgin forest near river, May 1927.

37. *Erythrodiplax erichsoni*, Kirby, 1894.

One ♂, Santa Cruz, Dec. (Sp.M.).

38. *Erythrodiplax latimaculata*, form *a*, Ris, 1911.

Five ♂♂, Melguierra, by small isolated lake in open scrub, 1.vi. 27; two ♂♂, "Matto Grosso" (Ris (1)).

39. *Erythrodiplax attenuata* (*venusta*, Kirby), Kirby, 1889.

One damaged ♂, Cachoeira (Calvert (2)).

40. *Erythrodiplax minuscula*, Ramb., 1842.

One ♀, Cuyabá, in scrub near town; one ♂, Melguierra, in virgin forest, May 1927; twenty-seven ♂♂ and fourteen ♀♀, Chapada, May and Dec. (Calvert (2)); one ♂, Corumbá, May (Calvert (2)); three ♂♂ and six ♀♀, Cuyabá (lakes), Jan. (Calvert (2)); six ♂♂ and eight ♀♀, Cachoeira Cuyabá (Calvert (2)).

41. *Erythrodiplax maculosa*, Hagen, 1861.

One ♀, "Matto Grosso" (Ris (1)).

42. *Erythemis plebeja* (*verbenata*, Hagen), Burm., 1839.

Two ♀♀, Corumbá, waste ground near water, 16.iv.27; three ♀♀, Corumbá, May (Calvert (2)); one ♀, Uacaryzal (Calvert (2)).

43. *Erythemis haematogastra*, Burm., 1839.

One ♂, Cachoeira Cuyabá (Calvert (2)); one ♂, Cuyabá (Calvert (2)); one ♂, Uacaryzal (Calvert (2)).

44. *Erythemis peruviana*, Ramb., 1842.

One ♂, Corumbá, waste ground near water, 16.iv.27; three ♂♂ and one ♀, Cuyabá (lakes), Jan. 1886 (Calvert (2)); one ♂ and one ♀, Cachoeira (Calvert (2)); one ♂ and one ♀, Uacaryzal (Calvert (2)); two ♂♂, "Matto Grosso" (Sp.M.).

45. *Erythemis attala*, Selys, 1857.

One ♂, Cachoeira Cuyabá (Calvert (2)).

46. *Erythemis credula*, Hagen, 1861.

One ♀, Cuyabá (Calvert (2)); one ♂ and one ♀, Cachoeira (Calvert (2)); two ♂♂ and two ♀♀, Uacaryzal (Calvert (2)); one ♂, Corumbá, April (Calvert (2)).

47. *Lepthemis vesiculosa*, Fabr., 1775.

One ♂ and one ♀, Urucum, at edge of virgin forest, April 1927; one ♂, Nobres, in virgin forest near water, May 1927; one ♂, Chapada, Dec. (Calvert (2)); two ♂♂, Corumbá, Jan. (Sp.M.).

48. *Rhodopygia hollandi*, Calv., 1907.

One ♀, Melguierra, in virgin forest near water, 29.v.27; eleven ♂♂, Chapada (Calvert (2)); one ♂, Cachoeira (Calvert (2)); three ♂♂ and one ♀, Cuyabá (lakes), Jan. 1886 (Calvert (2)).

49. *Rhodopygia cardinalis*, Erichs., 1848.

One ♂, " Matto Grosso " (Ris (1)).

50. *Brachymesia* (*Cannacria*) *batesi*, Kirby, 1889.

One ♂ and one ♀, Chapada (Calvert (2)).

*51. *Dythemis multipunctata*, Kirby, 1894.

Two ♂♂ and one ♀, Cuyabá, in scrub near town; one ♀, Nobres, on the trail from Cuyabá to Diamantino, May 1927.

52. *Dythemis cannacrioides*, Calv., 1906.

Four ♂♂ and one ♀, Chapada (Calvert (2)).

53. *Brechmorhoga nubecula*, Ramb., 1842.

One damaged ♂, Chapada, Nov. (Calvert (2)); two ♂♂ and one ♀, Dec., Chapada (Calvert (2)).

54. *Brechmorhoga praedatrix*, Calv., 1909.

Five ♂♂, Chapada (Calvert (2)); ♀ unknown.

55. *Macrothemis hemichlora*, Burm., 1839.

Two ♂♂ and two ♀♀, Cuyabá, in scrub near town; one ♂, Nobres, near water; one ♀, Melguierra, near water, May 1927; three ♀♀, Chapada (Calvert (2)).

*56. ? *Macrothemis valida*, Navás, 1916.

One ♂, Urucum, in thinned forest, 29.iv.27.

57. *Macrothemis imitans*, Karsch, 1890.

Two ♂♂ and one ♀, Chapada (Calvert (2)).

58. *Macrothemis pseudimitans*, Calv., 1898.

Three ♂♂, Chapada, May (Calvert (2)).

59. *Macrothemis flavescens*, Kirby, 1897.

One ♂, Rio Cuyabá, Jan. 1886, and one ♂, Cachoeira Cuyabá in open place near river, Jan. (Calvert (2)).

60. *Macrothemis musiva*, Calv., 1898.

One ♂, Campo Grande, on N.W. Railway, in open scrub near river, 10.iv.27; one ♂, Melguierra, virgin forest near river, 29.v.27; one ♂, Chapada (Calvert (2)).

61. *Gynothemis venipunctata*, Calv., 1909.

Eighteen ♂♂ (fifteen damaged), and four ♀♀ (all damaged), Chapada (Calvert (2)).

62. *Gynothemis* (*Brechmorhoga*) *heteronycha*, Calv., 1909.

Seven ♂♂ (six damaged) and three ♀♀, Chapada (Calvert (2)). Calvert placed *heteronycha* in the genus *Brechmorhoga*, but Ris, after examining the series in the Coll. Selys and the Coll. Needham from Brazil, and in the Brit. Mus. from Paraguay, states that it should undoubtedly come under Calvert's new genus *Gynothemis*.

*63. *Tholymis citrina*, Hagen, 1867.

One ♀ flew aboard the boat on the Rio Cuyabá, May 1927.

64. *Tramea cophysa*, Hagen, 1867.

One ♀ taken at Cuyabá, in scrub near town, 16.v.27, is undoubtedly the form *a* of Ris, the large dark brown patch at the base of the wings being very well marked. Of the typical form *c*, one ♀ was taken at Urucum at edge of virgin forest, 23.iv.27; two ♀♀ taken at the same place in thinned forest, 29.iv.27; one ♀ taken at Cuyabá in scrub near town, 11.v.27; two ♂♂ taken in the same place, 18.v.27; the three last were taken in the same locality and within a few days of the ♀ form *a*. One ♂, Cuyabá, and two ♂♂, Corumbá, May (Calvert (2)), were tentatively referred by Calvert to *Tramea longicauda*, Brauer, var. ?, but Ris says they are certainly not the *T. longicauda*, Brauer, var., and places them under *T. cophysa*. Seven ♂♂ and three ♀♀, Chapada (Calvert (2)), named by Calvert *Tramea cophysa* ?, have also been placed under this species by Ris.

65. *Tramea binotata*, Ramb., 1842.

Under this species Ris includes *Tramea brasiliana*, Brauer, 1867, two ♂♂ of which were taken at Chapada by H. H. Smith (Calvert (2)).

*66. *Tauriphila australis*, Hagen, 1867.

One ♂ and one ♀, Urucum, at edge of virgin forest, April 1927.

67. *Miathyria marcella*, Selys, 1857.

Very common on waste ground and in secondary growth. One ♂ and five ♀♀, Corumbá; two ♂♂ and one ♀, Urucum; one ♂ on grass-covered top of mountain, Urucum, at 2300 feet; one ♀ flew aboard the boat on the Rio São Lourenço, connecting the rivers Paraguay and Cuyabá, April 1927; seventeen ♂♂ and five ♀♀, Chapada (Calvert (2)); one ♂ and one ♀, Corumbá, May (Calvert (2)); one ♂, " Matto Grosso " (Sp.M.).

68. *Miathyria simplex*, Ramb., 1842.

One ♀, Corumbá, April (Calvert (2)).

69. *Neocordulia volexmi*, Selys, 1874.

One ♂ and two ♀♀, Chapada, in the Museum of Comparative Zoology, Cambridge, Mass., U.S.A. (Calvert (2)).

70. ? *Dorocordulia errans*, Calv., 1909.

One ♂ (minus head), Chapada (Calvert (2)); ♀ unknown. Calvert, in describing this new species, says—" It is surprising, however, to find what appears to be a *Dorocordulia* in southern Brazil, as the genus has not hitherto been known south of Maryland. There is, therefore, ground for suspecting that the locality-label may have been misplaced."

Family AESHNIDAE.

71. *Anax longipes*, Hagen, 1861.

One specimen from Matto Grosso (Calvert (1)).

*72. *Coryphaeschna longfieldae*, Kimmins, 1929.

One ♂, Burity, at edge of virgin forest, 19.vi.27.

73. *Coryphaeschna luteipennis*, Burm., 1839.

One ♀, Chapada (Calvert (1)).

74. *Coryphaeschna virens*, Ramb., 1842.

One ♂ flew aboard the boat on the Rio Cuyabá, 6.v.27; one ♂, Chapada (Ris (3)).

75. *Coryphaeschna adnexa*, Hagen, 1861.

One ♂, Urucum, at edge of virgin forest, 28.iv.27; one ♀, Chapada (Calvert (1)).

*76. *Coryphaeschna perrensi*, MacLachlan, 1887.

One ♂, Urucum, at edge of virgin forest, 18.iv.27.

*77. *Staurophlebia reticulata*, Burm., 1839.

One ♀ taken by C. L. Collenette, Burity, in virgin forest, 19.ix.27.

78. *Progomphus intricatus*, Selys, 1857.

Thirteen ♂♂, Chapada (Calvert (2)).

79. ? *Progomphus pygmaeus*, Selys, 1873.

One damaged ♀, Chapada (Calvert (1)).

80. *Progomphus recticarinatus*, Calv., 1909.

Five ♂♂, Chapada (Calvert (2)).

81. *Epigomphus hylaeus*, Ris, 1916.

One ♂, " Matto Grosso " (Ris (3)).

*82. *Gomphoides producta*, Selys, 1857.

One ♀ taken at the Rio de Casca waterfall, Chapada, at 2370 ft. in virgin forest, 16,vi.27.

83. *Gynacantha trifida*, Ramb., 1842.

One ♂, Chapada, in the Museum of Comparative Zoology, Cambridge, Mass., U.S.A. (Calvert (1)).

84. *Gynacantha nervosa*, Ramb., 1842.

One ♂, Chapada, and one ♀, Cachoeira (Calvert (1)).

Family AGRIONIDAE.

*85. *Lais cuprea*, Selys, 1853.

One ♂, Melguierra, in virgin forest near water, 29.v.27.

86. *Lais pudica*, Selys, 1853.

Five ♂♂ (four damaged) and six ♀♀ (four damaged), Chapada (Calvert (2)).

*87. *Lais smaragdina*, Selys, 1869.

Three ♂♂, Burity, in virgin forest away from water, June 1927.

88. *Lais guttifera*, Selys, 1873.

One ♂, Urucum, at edge of virgin forest, 19.iv.27; one ♀, Burity, in virgin forest away from water, 19.vi.27; fourteen ♂♂ (eight damaged) and twelve ♀♀ (seven damaged), Chapada (Calvert (2)).

89. *Hetaerina rosea*, Selys, 1853.

Five ♂♂ and eight ♀♀, Melguierra, in virgin forest near water, May 1927; one ♂, in the same locality, June 1927; fifteen ♂♂ (eight damaged) and twenty-one ♀♀ (all damaged), Chapada (Calvert (2)).

*90. *Hetaerina laesa*, Hagen, 1853.

One ♂ and one ♀, Melguierra, in virgin forest near water, May 1927.

*91. *Hetaerina divina*, Hagen, 1854.

Two ♀♀, Burity, in virgin forest away from water, June 1927. Compared with one of Hagen's original specimens in the Brussel's Natural History Museum by M. Antoine Ball. Measurements—abd., 27–29 mm.; hind-wing, 24–26 mm.

*92. *Hetaerina fuscoguttata*, Selys, 1878.

One ♀, Melguierra, in virgin forest near water, 25.v.27.

93. *Hetaerina fuscibasis*, Calv., 1909.

Three ♂♂ and one ♀ taken by C. L. Collenette, Burity, near water, 7.x.27; eight ♂♂ (six damaged) and eight ♀♀ (six damaged), Chapada, May (Calvert (2)).

94. *Heliocharis amazona*, Selys, 1853.

One ♂, Melguierra, in virgin forest near water, 30.v.27; two ♂♂, Chapada (Calvert (2)).

95. *Chalcopteryx rutilans*, Ramb., 1842.

Two ♂♂ and one ♀, Melguierra, in virgin forest near water, May 1927; three ♂♂ and two ♀♀ taken by C. L. Collenette, Burity, near water, Oct. 1927; nine ♂♂ (eight damaged), Chapada (Calvert (2)).

96. *Chalcopteryx radians*, Ris, 1914.

Five ♂♂ and two ♀♀, " Matto Grosso " (Ris (2)).

97. *Mecistogaster linearis*, Fabr., 1776.

One ♂, " Matto Grosso " (Ris (3)).

98. *Mecistogaster ornatus*, Ramb., 1842.

Four ♂♂ and two ♀♀ taken by C. L. Collenette in virgin forest, Falls of Tombador, Rio Serragem, on the trail from Cuyabá to Diamantino, Aug. 1927; one ♀, Burity, Sept. 1927; one ♂ and five ♀♀, " Matto Grosso " (Ris (3)).

99. *Heteragrion triangulare*, Hagen, 1862.

Four ♂♂ and two damaged ♀♀, Chapada (Calvert (2)).

100. *Perilestes cornutus*, Selys, 1886.

Two ♂♂, Villa Murtinho, April 1922 (Williamson (2)).

101. *Perilestes attenuatus*, Selys, 1886.

Four ♂♂ and one ♀, Abuná, March 1922 (Williamson (2)).

102. *Perilestes kahli*, Williamson, 1924.

One ♂, April 1922 (Williamson (2)).

103. *Perilestes solutus*, Williamson, 1924.

Fifty ♂♂ and thirteen ♀♀, March and April 1922 (Williamson (2)). Mr. Williamson also includes in this new species, two ♂♂ and two ♀♀, from Chapada (Calvert (2)), doubtfully referred by Calvert to *P. fragilis*, Hagen.

104. *Protoneura capilliformis*, Selys, 1886.

Three ♂♂ and one ♀, Chapada (Calvert (2)).

105. *Argia oculata*, Hagen, 1865.

Thirteen ♂♂ (ten damaged) and eight ♀♀, Chapada (Calvert (2)).

106. *Argia reclusa*, Selys, 1865.

One ♀, Campo Grande, N.W. Railway, in open scrub near river; one ♂, Urucum, at edge of virgin forest, April 1927; four ♀♀, Nobres, on the trail from Cuyabá to Diamantino, near river; one ♂ and three ♀♀, Melguierra, in virgin forest near river, May 1927; thirty-five ♂♂ and twenty-eight ♀♀ (twenty damaged), Chapada (Calvert (2)).

107. *Argia mollis*, Selys, 1865.

Two ♂♂ and one ♀, Urucum, in virgin forest away from water, April 1927; one ♀, Melguierra, in virgin forest near river, May 1927; one ♂, Burity, by small pond in open scrub, June 1927; twenty-seven ♂♂ and twenty-seven ♀♀ (fourteen damaged), Chapada (Calvert (2)).

108. *Argia chapadae*, Calv., 1909.

Three ♂♂ and one ♀, Melguierra, in virgin forest near river, May 1927; eleven ♂♂ and one ♀, Chapada (Calvert (2)).

109. *Argia smithiana*, Calv., 1909.

One ♂, Melguierra, in virgin forest near river, 23.v.27; seventeen ♂♂ and thirteen ♀♀ (nine damaged), Chapada (Calvert (2)).

110. *Argia tamoyo*, Calv., 1909.

One ♂, Chapada (Calvert (2)).

111. *Argia thisma*, Calv., 1909.

Nine ♂♂, Chapada (Calvert (2)); ♀ unknown.

112. *Argia tupi*, Calv., 1909.

Four ♂♂, Chapada (Calvert (2)); ♀ unknown.

113. *Argia botacudo*, Calv., 1909.

Fifteen ♂♂ (ten damaged) and three ♀♀, Chapada (Calvert (2)).

114. *Argia subapicalis*, Calv., 1909.

Five ♂♂, Chapada (Calvert (2)); ♀ unknown.

115. *Argia hasemani*, Calv., 1909.

One ♂ and one ♀, Melguierra, in virgin forest near river, May 1927; one ♂, Nivac (E.D.J.); also one ♂, "Sierra da Chapada," in the British Museum.

116. *Diargia bicellulata*, Calv., 1909.

Nine ♂♂ and one ♀, Chapada (Calvert (2)).

117. *Ceratura capreola*, Hagen, 1861.

Five ♀♀, Cuyabá, by small pond in scrub, 19.v.27; two ♂♂ and two ♀♀, Burity, by small pond in open scrub, 14.vi.27; three ♂♂, Chapada (Calvert (2)); two ♂♂, Cuyabá (Calvert (2)); two ♂♂ and one citron ♀, Cachoeira Cuyabá (Calvert (2)); one orange ♀, Cachoeira (Calvert (2)).

118. *Oxyagrion basale*, Selys, 1876.

One ♂, Cuyabá, by small pond in scrub, 19.v.27; twenty-eight ♂♂ (twenty damaged) and five ♀♀, Chapada (Calvert (2)).

119. *Oxyagrion evanescens*, Calv., 1909.

Eight ♂♂, Chapada (Calvert (2)); ♀ unknown.

120. *Oxyagrion divaricatum*, Calv., 1909.

Ten ♂♂ and five ♀♀, Chapada (Calvert (2)).

121. *Oxyagrion impunctatum*, Calv., 1909.

Nine ♂♂ (seven damaged), Chapada (Calvert (2)); ♀ unknown.

*122. *Acanthagrion gracile*, Ramb., 1842.

One ♀ associated with the males of *A. gracile minarum* mentioned below; one ♂, Melguierra, in virgin forest near water, 1.vi.27.

123. *Acanthagrion gracile minarum*, Selys, 1876.

Five ♂♂, Cuyabá, by small pond in scrub, May 1927; forty ♂♂ (twenty-five damaged) and four ♀♀, Chapada (Calvert (2)).

124. *Acanthagrion gracile ascendens*, Calv., 1909.

One ♂, Cachoeira (Calvert (2)).

125. *Acanthagrion truncatum*, Selys, 1876.

Three ♂♂, Burity, by small pond in open scrub; one ♂, Burity, in wet lane,

June 1927; thirty ♂♂ (eighteen damaged) and three ♀♀, Chapada, May (Calvert (2)).

126. *Acanthagrion temporale*, Selys, 1876.

One ♂, Cuyabá, by small pond in scrub, 18.v.27; two ♂♂ and one ♀, Cachoeira Cuyabá, Jan. (Calvert (2)); sixteen ♂♂ (ten damaged) and one ♀, Chapada (Calvert (2)).

127. *Acanthagrion chacoënse*, Calv., 1909.

One ♂ flew aboard the boat on the Rio Cuyabá, 6.v.27; one imperfect ♂, Corumbá, May (Calvert (2)). Calvert's type was a single ♂ from Piedra Blanca, Bolivia, four miles west of Corumbá; ♀ unknown.

128. *Acanthagrion cuyabae*, Calv., 1909.

Seven ♂♂, Cuyabá (Calvert (2)); one ♂, Uacaryzal (Calvert (2)); nine ♂♂, Cachoeira Cuyabá (Calvert (2)); ♀ unknown.

129. *Acanthagrion chararum*, Calv., 1909.

Eight ♂♂, Cuyabá (Calvert (2)); two ♂♂, Cachoeira (Calvert (2)).

130. *Acanthagrion chirihuanum*, Calv., 1909.

Two ♂♂ (one damaged), Cuyabá (Calvert (2)); ♀ unknown.

131. *Skiallagma simulacrum*, Calv., 1909.

Thirteen ♂♂ (nine damaged), Cuyabá (Calvert (2)); one damaged ♂, Cachoeira Cuyabá (Calvert (2)); ♀ unknown.

132. *Acanthallagma strohmi*, Williamson, 1924.

Seventeen ♂♂ and thirteen ♀♀, Abuná, March 1922 (Williamson (1)).

133. *Acanthallagma luteum*, Williamson, 1924.

Nine ♂♂ and three ♀♀, Villa Murtinho, March and April 1922 (Williamson (1)).

134. *Telebasis coccinata*, Calv., 1909.

Two ♂♂, Burity, by small pound in open scrub, June 1927; four ♂♂, Chapada (Calvert (2)); ♀ unknown.

135. *Telebasis carmesina*, Calv., 1909.

One ♂, Chapada (Calvert (2)); ♀ unknown.

136. *Telebasis sanguinalis*, Calv., 1909.

Twenty-three ♂♂ (fourteen damaged) and four ♀♀, Chapada (Calvert (2)).

137. *Telebasis carminita*, Calv., 1909.

One ♂, Cuyabá (Calvert (2)); one ♂, Cachoeira Cuyabá (Calvert (2)); ♀ unknown.

138. *Leptobasis mammilaris*, Calv., 1909.

Two ♂♂ (one damaged), Chapada (Calvert (2)).

139. *Metaleptobasis bicornis*?, Selys, 1877.

One damaged ♂, Chapada (Calvert (2)). Selys described the species from one ♀.

140. *Ischnura ?nepos*, Selys, 1876.

Three ♂♂ and one ♀ (homochromatic), Urucum, came to light in cleared land near forest, 19.iv.27; one ♂ flew aboard the boat on the Rio São Lourenço, 4.v.27; one ♂, one ♀ (hom.), one ♀ (heterochromatic *a.*), and one ♀ (het. *b.*), Cuyabá (Calvert (2)); one ♀ (hom.), Cachoeira (Calvert (2)); three ♂♂, two ♀♀ (het. *b.*), and one ♀ (het. *c.*), Cachoeira Cuyabá (Calvert (2)); one ♀ (hom.), Chapada (Calvert (2)); three ♀♀ (hom.), Uacaryzal (Calvert (2)); two ♂♂ and one ♀ (hom.), Corumbá (Calvert (2)). Calvert mentions three distinct forms of heterochromatic females: *a.*, *b.* and *c.* Both Selys and Calvert doubtfully referred this species to the genus *Ischnura*.

141. *Ischnura fluviatilis*, Selys, 1876.

One ♂, Cachoeira Cuyabá (Calvert (2)).

142. *Ischnura fluviatilis*, var. *bizonata*, Selys, 1876.

One orange ♀, Uacaryzal (Calvert (2)).

143. *Neoneura sylvatica*, Selys, 1886.

Three ♂♂, Melguierra, in virgin forest near river, 23.v.27; one ♂, Chapada (Calvert (2)); one damaged ♂, Cachoeira (Calvert (2)).

144. *Neoneura fulvicollis*, Selys, 1886.

One ♂, Uacaryzal (Calvert (2)); one damaged ♂, Rio Cuyabá, Jan. (Calvert (2)).

145. *Tigriagrion aurantinigrum*, Calv., 1909.

Nine ♂♂ (five damaged) and one ♀, Chapada (Calvert (2)).

*146. *Lestes forficula*, Ramb., 1842.

Three ♂♂, and one pair taken *in cop.*, Cuyabá, by small pond in scrub, 14.v.27.

147. *Lestes pictus*, Hagen, 1862.

One ♂, Chapada (Calvert (2)).

148. *Lestes bipupillatus*, Calv., 1909.

Twenty-five ♂♂ (twelve damaged) and nine ♀♀, Chapada (Calvert (2)).

149. *Lestes mediorufus*, Calv., 1909.

One ♂, Chapada (Calvert (2)).

150. *Lestes paulistus*, Calv., 1909.

One ♂ (minus head), Cachoeira (Calvert (2)); two badly damaged ♂♂, Cuyabá (Calvert (2)).

151. *Lestes dichrostigma*, Calv., 1909.

One ♂, Chapada (Calvert (2)).

152. *Lestes quadristriatus*, Calv., 1909.

The type, a single ♂, has lost the head, one other ♂ and two ♀♀ badly damaged, Chapada (Calvert (2)).

THE SOUTH-WEST SIDE OF THE SERRA DA CHAPADA, WITH TYPICAL SCRUB COUNTRY IN THE FOREGROUND.

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HYMENOPTERA COLLECTED ON THE " ST. GEORGE " EXPEDITION IN CENTRAL AMERICA AND THE W. INDIES

By L. Evelyn Cheesman, F.Z.S.

[Read May 1st, 1929.]

With Nine Text-figures.

The following Hymenoptera form part of a collection of insects made while on the " St. George " Expedition to the Pacific (1924–25); with additional material collected on Martinique and La Guadaloupe after leaving the expedition.

In the first part of the time the yacht paid visits of varying duration to Trinidad, B.W.I.; the Panama Zone (including Taboga Is.); Coiba Is., Costa Rica; Isla del Rey, Pearl Is.; Gorgona Is., Colombia; and the Galapagos Is. No encampments were formed, but daily expeditions were made from the yacht.

In the second part of the time the expedition proceeded south-west and visited islands of the Marquesas, Tuamotu, and Society groups. The collection of insects made upon these island groups of the south-east Pacific has been worked out separately and the results published.

The longest period spent in one locality during the first part of the voyage was upon Gorgona; an interesting, volcanic island, covered with tropical forest, and situated 19 miles from the mainland. The bulk of the entomological material of the first part of the voyage was collected on this island, a second visit to which was made possible by the generosity of one of the passengers, Mr. Grant, of Cullompton, Devon, who at personal inconvenience furnished the necessary funds.

The island possesses a rich insect fauna which is mainly Central American, many of the species being also found in S. Mexico.

The Halictines are being considered by Miss Grace Sandhouse, and the Ants by Dr. Mann. No reference is made to these groups, therefore, in the following pages.

All material, except where otherwise stated, was collected by the author.

For the work done upon this collection I have gratefully to acknowledge the aid of a research grant from the Royal Society.

APOIDEA.

ANDRENIDAE.

1. *Megalopta genalis*, Meade Waldo.

Meade Waldo, Ann. Mag. Nat. Hist., (8), xvii, p. 453, 1916. ♀ (Panama).

Gorgona Is., Colombia, 3 ♀♀ July, 1 ♀ Oct., 1924, at light (*Miss Longfield*); 1 ♀ July, 2 ♀♀ Oct., 1924, on blossoms.

The character on which Meade Waldo based this species, namely the tuberculary produced genae, is only present in the largest specimens of the above series.

ANTHOPHORIDAE.

2. *Epicharis rustica*, Oliv.

Olivier, Encycl. Méth. Ins., iv, p. 64, 1789. (Am. Mer.)

Gorgona Is., Colombia, 1 ♀ July, 1924.

Distribution :—Am. Mer. There are specimens in the B.M. from Trinidad, B.W.I.

3. *Cyanocentris maculifrons* (Sm.).

Centris maculifrons, Smith, Cat. Hym. B.M., ii, p. 372, 1854. ♀ (Brazil).

Gorgona Is., Colombia, 1 ♀ July, 1924.

4. *Centris versicolor* (Lep.), F.

Apis versicolor, Fabricius, Syst. Ent., p. 386, 1775. (Am. Mer.)

Cristobal, Panama, 1 ♀ June, 1924.

Distr.—Am. Mer. There are specimens in the B.M. from W. Indies and Colombia.

5. **Tetrapedia acuticollis,** sp. n. (Fig. 1.)

♀. Black; shining. Legs dark brown. Antennae piceous beneath. Fringe of hair on clypeal margin golden brown, a few silvery hairs on lower part of cheeks. Scopa of posterior tarsi light brown on the upper half; thin hair fringe on 2nd, 3rd, and 4th abdominal

Fig. 1.—*Tetrapedia acuticollis*, sp. n. ♀. Pronotum. Front view.

sternites whitish, on 5th dark brown. Wings pale fulvous-brown, slightly darker basally; veins fulvous.

Head with a pronounced carina. Vertex smooth; distance between posterior ocelli less than diameter of one ocellus. Face one-sixth wider than its length. Frons buccate, the raised part coarsely punctate with median impression, the sides with minute sparse punctures from which spring fine hairs. Clypeus buccate with coarse punctures and a deep transverse sulcus. Mandibles bidentate, the basal tooth short and obtuse. Antennal segments three to five measure proportionately 12, 5, 8. Pronotum with posterior margin upturned in a vertical lamina, strongly produced laterally in an obtuse angle (fig. 1). Mesonotum matt with minute, dense punctation, a median impression more distinct anteriorly and two pairs of longitudinal impressions, those nearer the centre faint and long, the lateral distinct and short. Scutellum roundly produced, with fine, irregular punctures, very short black hairs (visible under high power) and a few scattered longer hairs laterally.

Propodeon and abdomen impunctate; bristles of 5th and 6th tergites rather short. 2nd cubital cell of fore-wing receives recurrent nervure beyond the middle.

Length 7 mm.

Gorgona Is., Colombia, Oct. 1924.

Five females were taken on blossoms of a Composite plant together with a *Trigona guianae*, Ckll., which they superficially resemble.

XYLOCOPIDAE.

6. *Xylocopa darwini*, Ckll. (Fig. 2 A, B.)

Cockerell, Ann. Mag. Nat. Hist., (9), xvii, p. 659, 1926. ♀ (Galapagos Is.).

♂. Fulvous brown; densely clothed in long, golden pubescence; apical margins of abdominal tergites fuscous.

Face yellow; narrow fasciae outlining clypeus, and continued to base of antennae, median line extending from between antennae to anterior ocellus, and continuing between posterior ocelli, and mandibles, except a basal fascia, black. Antennae fuscous beneath.

Fig. 2.—*Xylocopa darwini*, Ckll. ♂. Anterior coxa and trochanter. A. outer. B. inner aspect.

Apical third of 2nd abdominal tergite, and apical half of 1st and 3rd–5th with fuscous brown margins, wider laterally and narrowed again immediately with obscure fasciae of a lighter brown. Sternites with narrow white marginal hair bands interrupted medially, and visible under the sub-erect golden pubescence. Inner side of anterior coxae and their bases black; tibiae suffused with orange on the outer side; orange pubescence on inner side of intermediate basal tarsal segment; posterior and intermediate coxae and femora black. Golden-brown hair of apical segments intermixed with tufts of orange and black on 7th tergite laterally at the base. Wings fuscous, deeper on the costa; nervures fuscous brown.

Third antennal segment slightly longer than 4th plus 5th. Abdominal dorsum with dense rather fine punctation, no impunctate median areas, the impunctate anterior margin narrow, slightly wider in the centre and not extending to the sides.

Galapagos Is., Charles, 5 ♀♀; also 1 ♂, 1 ♀ taken flying (*Miss Longfield*), James, 3 ♂♂, 3 ♀♀; Indefatigable, 9 ♀♀; Albemarle, 10 ♀♀. July, 1924.

Williams records a difference in wing-coloration (*Proc. Calif. Acad. Sci.* (4), ii, pt. 2, No. 18, p. 257, 1926), which he suggests is an insular variation; but the above series shows that while the form with greenish-blue iridescence occurs upon all four islands visited, on three of the islands—namely Charles, Indefatigable, and Albemarle—the form with bluish-purple iridescence is also present. It is by no means evident that the bees of this species do not leave the island where

they have emerged. Twice I saw a female out at sea flying at some distance from land, one occasion being whilst we were approaching Albemarle, when at 9 a.m. a female flew almost over the yacht in a straight line, coming from the direction of the island, which was about eight miles distant.

7. *X. fimbriata*, F.

Fabricius, Syst. Piez., p. 340, 1804. (Cayenne.)

Taboga Is., 1 ♀ Sept., 1924.

Distr.—S. America and W. Indies.

8. *X. ordinaria*, Sm.

Smith, Trans. Ent. Soc., p. 292, 1874. ♀ (Brazil, near Rio).

Martinique, 1 ♂, 1 ♀ Sept., 1925.

The female agrees with the type, and the male with other males from Trinidad placed under this species in the B.M.

9. *Xylocopa*, sp.

Pearl Is., 1 ♀ Sept., 1924.

Entirely black; not in good condition.

NOMADIDAE.

10. *Mesonychium regalis* (Sm.).

Melissa regalis, Smith, Cat. Hym. B.M., ii, p. 280, 1854. ♂♀ (Brazil).

Old Panama, Coast, 1 ♀ June, 1924.

Middle teeth of pecten of intermediate calcar weak and definitely smaller than in the type, and the sides of calcar almost pectinate, whereas in the type they are obscurely serrate; also the basal half of 5th abdominal tergite has a brassy tinge in the above specimen. Since neither of these characters is stable (the form of pecten and number of teeth may even differ on one specimen), I forbear to make a new variety, but it would be of interest to examine a further series from the Panama district.

MEGACHILIDAE.

11. *Megachile binotulata* (D.T.).

Dalla Torre, Cat. Hym., x, p. 422, 1896. *Megachile binotata*, Guér. Lucas (nec Guérin) in Sagra's Hist. fis., etc., Cuba, vii, p. 777, t. 19. ♀ 1856. St. Thomas, and environs of Havana.

Martinique, 2 ♀♀ Sept. 30, 1925.

12. *M. totonaca*, Cress.

Cresson, Trans. Amer. Ent. Soc., vii, p. 117, 1878. (Mexico.)

Gorgona Is., 5 ♀♀ July, 1924.

13. *M. zaptlana*, Cress.

Cresson, *l.c.*, p. 130, 1878. ♀.

Taboga Is., 1 ♀ Sept., 1924.

Distr.—Mexico.

14. *M. mutaticeps*, Ckll.

Cockerell, Ann. Mag. Nat. Hist., (9), xi, p. 457, 1923.

Taboga Is., 1 ♀ Sept., 1924.

Distr.—Br. Guiana.

15. *M. lobitarsis*, Sm.

Smith, New Species Hym. B.M., p. 76, 1879. ♂ (São Paulo, Brazil).

Taboga Is., 1 ♂ Sept., 1924.

Distr.—Brazil, Br. Guiana.

16. *M. candida*, Sm.

Smith, New Species Hym. B.M., p. 82, 1879. ♀♂ (Mexico).

Taboga Is., 2 ♂♂ Sept., 1924.

17. *Hypanthidium mexicanum*, Cress. ssp. *taboganum*, Ckll.

Cockerell, Canad. Ent., xlix, p. 252, 1917.

Taboga Is., 3 ♂♂, 3 ♀♀ Sept., 1924.

EUGLOSSIDAE.

18. *Glossura ignita* (Sm.).

Euglossa ignita, Smith, Ann. Mag. Nat. Hist., (4), xiii, p. 444, 1874. ♂ (Jamaica).

Gorgona Is., 2 ♀♀ July, 1924.

Head and thorax green, abdomen red, and posterior tibiae copper (as in type). The only females in the B.M. are from Para; these agree with the above specimens except in the coloration, which is entirely green.

Taken in the blossoms of scarlet hibiscus. These insects were so exceedingly swift on the wing that the only successful method of capture was by taking a stand beside half-opened blossoms in early morning and waiting for their visits.

The following six species all belong to Friese's *cordata* group :—

19. *Euglossa cordata* (L.).

Apis cordata, Linné, Syst. Nat., Ed. X, 1, p. 575, 1758. (Am. Mer.)

Taboga Is., 1 ♀ Sept., 1924.

Specimens in the B.M. from Para, Colombia, and W. Indies.

20. *E. variabilis*, var. *hemichlora*, Ckll.

Cockerell, Canad. Ent., xlix, p. 146, 1917. (Paramba, Ecuador.)

Gorgona Is., Colombia, 1 ♀ July, 1924 (*Miss Longfield*), 4 ♀♀ July and Oct., 1924.

I have not seen Cockerell's type nor that of *E.* var. *purpurea*, Friese, of which Cockerell suggests this may be a colour variety; but the coloration of the Gorgona specimens agrees with Cockerell's description, and they also agree structurally with two females from the type locality in the B.M. which were collected by Rosenberg, who also collected the type, presumably on the same occasion.

21. **E. cupreiventris**, sp. n. (Fig. 3.)

♀. Head and thorax green, abdomen bright copper-red; posterior tibiae and basa tarsal segment golden-green, the former with a pink tinge.

Ocelli large, space between posterior pair $1\frac{1}{4}$ the diameter of one ocellus. Mesonotum shining with rather coarse punctation, sparse on the disc (the spaces between punctures equal to the breadth of one puncture), dense at the sides and anteriorly; a median, anterior shining area with sparse punctures, fine and coarse mixed. Scutellum with coarser, sparser punctation, mixed with fine and also minute punctures; scutellar cushion small, narrow, less than a third the length of scutellum. Abdomen with very fine, sparse, very short, whitish, appressed pile, and scattered, erect, short, black hairs. First abdominal tergite with anterior half finely, densely punctate, and coarsely punctate basally, anterior margin

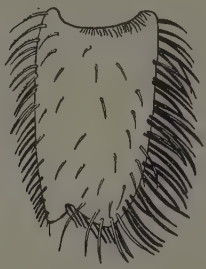

Fig. 3.—*Euglossa cupreiventris*, sp. n, ♀. Basal segment of posterior tarsus.

narrow, shining; second tergite with fine, dense punctures and narrow shining margin; the remaining tergites with coarser, very dense punctation, and rather broad shining margins, that of the 5th wider centrally extending back into a median impunctate area. Longitudinal row of dark brown bristles on inner margin of front surface of posterior tibiae, the bristles long (except the uppermost) almost as long as the pollinigerous hairs of the lateral fringe, and irregularly placed. Posterior basal tarsal segment nitidulous, apically produced on outer side.

Long. 11 mm.

Panama, 1 ♀ 1924. Panama, 1 ♀ (*F. Smith Coll., B.M.*).

This may be a subspecies of *variabilis*, Friese, but the punctation does not seem to agree with the description, and there are no other satisfactory female characters published.

22. **E. gorgonensis**, sp. n. (Fig. 4.)

♀. Green, shining; tending to bluish-green in some lights.

Mouth-parts reaching just beyond tip of abdomen. Vertex with impunctate areas in front of ocelli extending almost to inner orbits; space between posterior pair of ocelli equalling diameter of one ocellus. Thoracic dorsum with longish fuscous hairs. Meso-

notum with fine, sparse punctation, space between punctures two or three times the diameter of one puncture. Scutellum with punctation coarser apically, scutellar cushion large, oval, extending beyond middle of scutellum. Abdominal tergites with dense, very fine punctation, and broad anterior margins with minute punctures from which springs the appressed, very fine shining pile that covers the entire abdominal dorsum. A longi-

Fig. 4.—*E. gorgonensis*, sp. n. ♀. Basal segment of posterior tarsus.

tudinal row of five dark-brown, short, curved bristles on inner margins of front surface of posterior tibiae, the bristles shorter than pollinigerous hairs of lateral fringe and regularly placed. Basal segment of posterior tarsi narrow, the upper surface aciculate.

Long. 10 mm.

Gorgona Is., 2 ♀♀ July, 1924.

Distinguished by the sparse punctation of thoracic dorsum, and the punctation and pubescence of abdominal tergites.

23. **E. granti**, sp. n. (Fig. 5.)

Green, shining. Areas suffused with red on the frons. Mesonotum brassy: abdominal dorsum showing a variety of colours in certain lights—blue-green, copper, golden-green, red—and violet laterally.

Mouth-parts reaching just beyond posterior coxae. Vertex with impunctate area in

Fig. 5.—*E. granti*, sp. n. ♀. Basal segment of posterior tarsus.

front of ocelli extending almost to outer orbits; space between posterior pair of ocelli equals diameter of one ocellus. Thoracic dorsum densely covered with long, dirty-white hairs intermixed with longer black hairs. Punctation of mesonotum rather denser than in

gorgonensis. The pile of abdominal dorsum short and sparse, mixed with sub-erect dark hairs. Scutellar cushion extending almost to basal margin of scutellum. Punctation of 1st abdominal tergite fine, of the 2nd coarser with a narrow, shining, anterior margin impunctate save for infinitesimal punctures from which springs the fine pile; tergites 3–5 with coarser, irregular punctation, and narrow, shining anterior margins, that of the 5th tergite longer in the centre. A longitudinal row of five dark brown bristles on inner margin of front surface of posterior tibiae, the bristles definitely shorter than the pollinigerous hairs of lateral fringe—the uppermost shortest—and irregularly placed. Upper surface of basal segment of posterior tarsi aciculate except an impression on outer side at the base, hairs on the disc dark brown.

Long. 9·5 mm.

Gorgona Is., 1 ♀ July, 1924.

24. **E. championi**, sp. n. (Figs. 6, 7.)

Green, shining. Face purple-blue; clypeal disc dark-brown with white fasciae laterally (fig. 6). Thorax copper; abdomen copper or golden-green in different lights, in some specimens suffused with dull purple-red. Posterior tibiae green, basal tarsal segment green tinged with blue.

Mouth-parts reaching beyond posterior coxae. Thorax matt, with short whitish hairs

Fig. 6.—*Euglossa championi*, sp. n. ♂. Clypeus and mandibles.

Fig. 7.—*Euglossa championi*, sp. n. ♂. Basal segment of posterior tarsus.

mixed with longish black hairs; punctation of mesonotum coarse, rather sparse, space between punctures equals the diameter of one puncture. Scutellum coarsely reticulate-punctate with a dense tuft of short whitish hair tipped with dark brown in the position occupied by the scutellar cushion in females of this genus. This tuft is not present in some specimens of this series, and in others is of a uniform whitish colour. Abdominal tergites 1–4 densely, finely punctate with shining, rather broad anterior margins; that of the 4th longer in the centre: tergites 5 and 6 with coarser punctures anteriorly and broader shining margins. Second sternite covered with very dense, shining golden-brown pile, longer and denser in the centre, with dark brown fasciae laterally, shorter and less dense towards the lateral margins. Apex of posterior basal-tarsal segment laterally produced (fig. 7).

Long. 13 mm.

Panama, Chiriqui Valley, 2000–3000 ft., 17 ♂♂ 1913 (*G. Champion*).

Readily distinguished by the blue face, hair-tuft on scutellum and by the clothing of the 2nd abdominal sternite.

25. *E. dimidiata* (F.).

Apis dimidiata, Fabricius, Ent. Syst., ii, p. 316, 1793. (Surinam.)

Gorgona Is., 1 ♀ Oct., 1924. Taken in web of a large spider.

Distr.—Central America.

26. *E. dimidiata*, var. *flavescens*, Friese.

Friese, Termézett. Fuzet., xxii, p. 165, 1899. (Venezuela.)

Trinidad, B.W.I., 2 ♀♀ July, 1924.

Distr.—W. Indies, Central America.

APIDAE.

Meliponinae.

27. *Trigona parastigma*, Ckll.

Cockerell, Ann. Mag. Nat. Hist., (9), 1, p. 165, 1918.

Taboga Is., 7 ♀♀ Sept., 1924; Coiba Is., 2 ♀♀ Sept., 1924.

28. *T. pectoralis*, ssp. *panamensis*, Ckll.

Cockerell, *l.c.*, xii, p. 12, 1913.

Taboga Is., ♀♀ 5 Sept., 1924.

29. *T. interrupta* (Latr.).

Melipona interrupta, Latreille, Voy. Humboldt and Bonpland, i, p. 291, 1811.

Coiba Is., 1 ♀ Sept., 1924.

30. *T. guianae*, Ckll.

Cockerell, *l.c.*, vi, p. 366, 1910.

Gorgona Is., 27 ♂♂, 40 ♀♀ July and October, 1924.

A large colony was found nesting inside a living tree-trunk with a cerumen spout entrance 5½ inches in length, 2¼ inches wide, flattened dorsally. It was constructed with fragments of bark worked into the material so that it had the appearance of a broken branch. Colombian natives from the mainland informed me that they are in the habit of taking the nests of this species for the sake of the resinous material stored by the bees, described as being present in large, yellow lumps, which the fishermen use for caulking leaking canoes.

31. *T. fasciata*, var. *trinitatis*, Ckll.

Cockerell, Proc. U.S. Nat. Mus., lv, p. 201, 1919.

Trinidad, B.W.I., 3 ♀♀ May, 1924.

32. *T. amalthea* (Oliv.).

Apis amalthea, Olivier, Encycl. Méthod. Ins., iv, p. 78, 1789.

Trinidad, B.W.I., 14 ♀♀ May, 1924; Coiba Is., 19 Sept., 1924.

33. *T. fulviventris*, Guér.

Guérin, Iconogr. Régn. Anim., Ins., p. 464, 1844. (Mexico.)

Cristobal, Panama, 2 ♀♀ June, 1924.

34. *T. mosquito*, var. *variicolor*, Ducke.

Ducke, Comm. Linhas telegraph. Matto Grosso Amazon. Pub. 35. Annex. 5. Hist. Nat. Zool. Hym., p. 99, 1916.

Gorgona Is., 3 ♀♀ July, 1924.

35. *T. buyssoni*, Friese.

Friese, Zeitschr. Hym. u. Dipt., ii, p. 383, 1902. (Peru.)

Gorgona Is., 4 ♀♀ Oct., 1924.

36. *T. postica*, Ill.

Melipona postica, Illiger, Mag. f. Insectenk., v, p. 157, 1806.

Gorgona Is., 12 ♀♀ July and Oct., 1924.

37. *Nannotrigona testaceicornis* (Lep.). (Fig. 8.)

Trigona testaceicornis, Lepeletier, Hist. Nat. Ins. Hym., I, p. 429, 1836.

Taboga Is., 15 ♀♀, Sept., 1924; Coiba Is., 12 ♀♀ Sept., 1924; Isla del Rey, Pearl Is., 2 ♀♀ Sept., 1924.

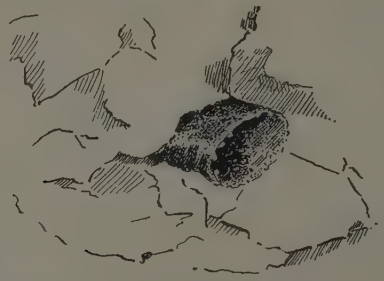

Fig. 8.—Entrance to nest of *Nannotrigona testaceicornis* (Lep.).

Nest in a stone wall on Taboga, the cerumen extension a flattened cylinder (fig. 8).

My thanks are due to Mr. H. Schwartz for kindly assisting me to identify the above species of *Trigona*.

SPHECOIDEA.

SPHECIDAE.

38. *Sceliphron fistulare* (Dahlb.).

Pelopeus fistulare, Dahlbom, Hymen. Europ., I, p. 22, 1843.

Gorgona Is., 4 ♂♂, 7 ♀♀ July and Oct., 1924.

One of the mud cells contained a Bombyliine larva (*Sphongostylum* sp.).

39. *S. coementarium* (Drury).

Pelopeus coementarius, Drury, Illus. Nat. Hist., i, p. 105, 1770.

Martinique, 1 ♀ Sept., 1925.

40. *Ammophila gracilis*, Lep.

Lepeletier, Hist. Nat. Ins. Hym., iii, p. 381, 1845.

Colon, 4 ♀♀ June, 1924.

41. *Sphex ichneumoneus* (L.).

Apis ichneumonea, Linné, Syst. Nat., Ed. X, i, p. 578, 1758.

Taboga Is., 1 ♀ Sept., 1924.

Distr.—Central America, W. Indies.

42. *Cerceris chiriquensis*, Cam.

Cameron, Biol. Centr. Amer. Hymen., ii, p. 114, 1890.

Panama, 1 ♀ June, 1924.

43. *Notogonia apicipennis*, Cam.

Cameron, *t.c.*, p. 58.

Martinique, 1 ♂ Sept., 1925.

44. *Tachytes ametina*, Cam.

Cameron, Timehri, J. R. Agric. Soc. Demerara, (3), ii, p. 436, 1912.

Trinidad, B.W.I., 1 ♀ June, 1924.

45. *T. argentipes*, Sm.

Smith, Cat. Hym. B.M., iv, p. 306, 1856. (St. Vincent.)

Taboga Is., 2 ♀♀ Sept., 1924.

46. *Tachytes* sp.

Taboga Is., 1 ♂ Sept., 1924.

47. *Stizus nanus*, Handl.

Handlirsch, Sitzber. Akad. Wiss. Wien, ci, p. 61, 1892. (Georgia.)

Cristobal, Panama, 4 ♂♂, 7 ♀♀ June, 1924.

One female varies in having two small yellow fasciae on the propodeon at the upper margin of the posterior face, and a narrow, yellow, longitudinal stripe above the tegulae.

48. *Monedula signata* (L.).

Vespa signata, Linné, Syst. Nat., Ed. X, i, p. 574, 1758.

Pearl Is., 5 ♀♀ July, 1924.

49. *Monedula gorgonensis*, Cheesm.

Cheesman, Ann. Mag. Nat. Hist., (10), ii, p. 102, 1928.

Gorgona Is., 1 ♂, 1 ♀ July, 1924.

50. *Bembidula*, sp.

Panama, 1 ♂ June, 1924.

VESPOIDEA.

SCOLIIDAE.

51. *Elis nitida* (Sm.).

Myzine nitida, Smith, Cat. Hym. B.M., iii, p. 77, 1855. (Jamaica.)

Martinique, 1 ♀ Sept., 1925.

Distr.—W. Indies.

52. *E. pulchrina* (Cam.).

Myzine pulchrina, Cameron, Biol. Centr. Amer., ii, p. 254, 1900. (Chiriqui.)

Taboga Is., 4 ♂♂ Sept., 1924.

Taken on blossoms and bred from a nest in a deserted larval case of *Perophora* sp.

53. *Dielis variegata* (F.).

Scolia variegata, Fabricius, Ent. Syst., ii, p. 230, 1793. (Cayenne.)

Taboga Is., 1 ♀ Sept., 1924.

54. *D. dorsata*, F.

Typhia dorsata, Fabricius, Mant. Ins., i, p. 279, 1787.

Colon, 1 ♂ June, 1924.

EUMENIDAE.

55. *Zethus braziliensis*, Sauss.

Saussure, Études Vesp. I. Eumen., p. 10, 1852.

Gorgona Is., 1 ♀ July, 1924.

56. *Eumenes octomaculatus*, Cam.

Cameron, Timehri, J. Agric. Soc. Br. Guiana, (3), ii, p. 229, 1912.

Trinidad, 3 ♀♀ June, 1924.

57. *Eumenes* sp.

Gorgona Is., 2 ♂♂, 1 ♀ July, 1924.

58. *Montezumia azurescens*, Spin.

Spinola, Mem. Accad. Sci. Torino (2), xiii, p. 83, 1851. ♂ (Am. Mer.).

Gorgona Is., 1 ♀ July, 1924.

59. *Odynerus grenadensis*, Ashm.

Ashmead, Trans. Ent. Soc., p. 234, 1900.

Trinidad, B.W.I., 1 ♀ June, 1924.

60. *Odynerus* sp.

Taboga Is., 2 ♂♂ Sept., 1924.

VESPIDAE.

61. *Polistes annularis* (L.).

Vespa annularis, Linné, Centur. Ins. Rar., p. 31, 1763 (Amoen. Acad. 6, p. 413, 1763).

Colon, Taboga Is., Gorgona Is., 13 ♀♀ July–Sept. 1924.

62. *P. canadensis*, var. *cincta* (Lep.).

Polistes cinctus, Lepeletier, Hist. Nat. Ins. Hym., p. 522, 1836. (Martinique.)

Martinique, W.I., 1 ♂ Sept., 1925.

Specimens in B.M. from Barbadoes. St. Vincent. Mustique Is.. Grenadines; also from F. Smith coll. labelled W. Indies, determined by Dr. Bequaert.

63. *P. binotatus*, Sauss.

Saussure, Études Vesp., ii, p. 87, 1853–58. (Brazil.)

Trinidad, B.W.I., 1 ♀ July, 1924.

64. *P. versicolor* (Oliv.).

Vespa versicolor, Olivier, Encycl. Méthod. Ins., vi, p. 692, 1791. (Brazil, St. Domingo.)

Gorgona Is., 3 ♀♀ July, 1924.

65. *Polistes* sp.

Taboga Is., 1 ☿ Sept., 1924.

66. *Polybia occidentalis* (Oliv.).

Vespa occidentalis, Olivier, *l.c.*, p. 675.

Panama; Taboga Is.; Trinidad, B.W.I., 8 ♀♀ June and Sept., 1924.

67. *P. fasciata* (Lep.).

Polistes fasciata, Lepeletier, Encycl. Méthod. Ins., x, p. 171, 1825. (Panama.)

Panama, 5 ♀♀ June, 1924.

68. *P. fuscicornis* (Lep.).

Agelaia fuscicornis, Lepeletier, Hist. Nat. Ins. Hym., i, p. 536, 1836.

Trinidad, 1 ♀ June, 1924.

69. *Polistes* sp.

Gorgona Is., 11 ♀♀ July, 1924.

70. *Stelopolybia vulgaris* (Ducke).

Polybia vulgaris, Ducke, Bol. Mus. Para, iv, p. 352, 1904.

Gorgona Is., 1 ☿, 24 ♀♀, July, 1924.

Nest in a land crab's burrow in the bank of a stream, the combs suspended from the roof of the burrow.

71. *Megacanthopus indeterminabilis* (Sauss.).

Polybia indeterminabilis, Saussure, Études Vesp., ii, p. 201, 1853. (Santa Lucia.)

Taboga Is., 2 ♀♀ Sept., 1924.

72. *Megacanthopus* sp.

Gorgona Is., 2 ♀♀ July, 1924.

73. *Mischocyttarus longipetiolata*, var. *drewseni* (Sauss.).

Mischocyttarus drewseni, Saussure, Ann. Soc. Ent. France, (3), v, p. 317, 1857.

Gorgona Is., 1 ♂, 2 ♀♀ July, 1924.

74. *Apoica pallida* (Oliv.).

Vespa pallida, Olivier, Encycl. Méthod. Ins., vi, p. 675, 1791.

Panama, 2 ♀♀; Coiba Is., 1 ♀ June, July, 1924.

75. *A. virginea* (F.).

Polistes virginea, Fabricius, Syst. Piez., p. 277, 1804.

Trinidad, B.W.I., 2 ♀♀ May, 1924.

76. *Synoeca surinama*, var. *ultramarina* (Sauss.). (Fig. 9.)

Synoeca surinama, Saussure, Ann. Soc. Ent. France (2), x, 1852.

Trinidad, 1 ♀ June, 1924; Gorgona Is., 7 ♀♀ July, 1924.

Fig. 9.—Nest of *Synoeca surinama*, var. *ultramarina* (Sauss.).

The Columbians on Gorgona asserted that this wasp, which can inflict a severe sting, would not attack anybody who remained silent, but disliked the sound of a human voice, especially if it were shrill or penetrating.

77. *Vespa cyanea* (F.).

Vespa cyanea, Fabricius, Syst. Ent., p. 372, 1775.

Pearl Is., 1 ♀; Colon, 1 ♀.

PACIFIC PYRALES OF THE "ST. GEORGE" EXPEDITION

By Edward Meyrick, B.A., F.R.S.

[Read June 5th, 1929.]

Subsequent to the completion of my paper published in the *Transactions of the Entomological Society of London* for 1928, pp. 489–521, on the Microlepidoptera of the "St. George" Expedition, I was asked to undertake the investigation of the Pyrales obtained at the same time in the Pacific islands; and although in recent years I have been unable to spare time for the general study of this group of the Lepidoptera, my acquaintance with the fauna of the surrounding regions seemed to justify my acceptance of the invitation.

The number of specimens in determinable condition is 1071, representing 56 species; of these 2 genera and 29 species are described as new. Where no collector's name is mentioned, the specimens were collected by Mr. C. L. Collenette and Miss C. E. Longfield; a portion of those from the Society Islands were collected by Miss L. E. Cheesman, and in the case of these her name is mentioned. Where no elevation is given, they were taken at low levels. Nearly all the specimens were obtained at light.

Only 4 families of the Pyralidina are represented, and of these the single species of Galleriidae certainly, and in all probability the two species of Pyralidae also, were introduced by human agency. The extensive family Crambidae has no representative, although its simple larval requirements—grasses and moss—are found everywhere.

Of the 53 species of Phycitidae and Pyraustidae, 18 are insects occurring also in the Australian or Papuan regions and generally ranging much further to India or Africa, sometimes throughout the hot regions of the world; some of these have great travelling powers (probably readily submitting to be carried by strong winds) and adaptability in respect of food-plants, others are doubtless transported by man; these must be set apart from the true native fauna. One other species, *Piletocera signiferalis*, ranges widely in the Pacific from the Caroline Islands to Rapa, but is not recorded elsewhere; its habits do not seem to be known, but it has probably been spread by native canoes. The remaining 34 species, so far as known, are all endemic and constitute the interesting portion of the collection; they are as follows:—

Aspithra (4 species), with 161 specimens, comprises more than one-seventh of the entire number of specimens taken; only one other species, founded on a single specimen from Ceylon, has been recorded. The genus is peculiarly distinct and easy of recognition by the neuration.

Phycita, *Etiella*, *Homoeosoma*, *Cateremna*, *Acrobasis*, *Eurhodope* (1 species each) are all considerable genera of wide range, well represented in the Indian and Australian regions.

Ctenomeristis (1 species) consists perhaps only of one or two Australian species.

Bradina (2 species) is of some extent and distributed through the Indo-Australian region, but also has several species endemic in Fiji and other Pacific islands.

Tatobotys (1 endemic species) is a small genus ranging from Ceylon to the Pacific.

Aulacodes, *Calamochrous*, *Pyrausta* (1 species each) are considerable genera of very wide distribution.

Margaronia (2 apparently endemic species) is very extensive and universally distributed in hot countries; endemic species occur in other Pacific islands, including the Hawaian, and some of the genus are known to be travellers.

Pythagoraea (1 species) is endemic and distinct, but possibly allied to *Dracaenura*, a genus of some extent, characteristic of the Papuan and Polynesian regions.

Idioblasta (2 species) is known only from the Marquesas; it is quite a peculiar form, of dubious affinity.

Scoparia (11 species) with 164 determinable specimens, is a very large and universally distributed genus, but not everywhere equally prominent; it seems to require damp air, and has a special liking for islands; its greatest developments are in New Zealand and the Hawaiian Islands.

Summarising these facts, and applying them to the hypothesis of a former largely extended land-area, Palaeonesia, advocated in my paper quoted above (to which reference should be made), it would appear that *Scoparia*, which has attained considerable development, and would probably on further collecting show 40 or 50 species, undoubtedly belongs to the Palaeonesian period; an additional point of interest in connection with this genus is that the species are of the same type as those found in the Hawaiian group (where there are over 60); the Marquesas forms in particular, which are the nearest geographically, harmonise well with the Hawaiian, implying a common geographical origin. I consider *Aspithra* and *Idioblasta* also referable to the same period; the specific development is less, but further representatives of these genera will no doubt be found: they are remarkably distinct and isolated, so that their affinity is only conjectural, and the individual species are well specialised, demanding a long period of time for their evolution. It is possible that *Pythagoraea* may belong to the same period, since it also appears isolated. but further evidence is required. All the other genera enumerated above seem to be just those disconnected and casual immigrants that might have been expected to occur, modified representatives of the adjacent western faunas.

Phycitidae.

Aspithra, Rag. (= *Mimistis*, Hamps.).

Antennae ♂ simple or dentate, ciliated. Labial palpi long, curved, ascending, terminal joint about as long as second or longer, pointed. Maxillary palpi short, porrected, filiform. Fore-wings 2 from angle, 3 and 5 stalked, connate with 2, 4 absent, 9 and 10 out of 8. Hind-wings transverse vein absent, 2 and 5 connate from apparent angle, 3 and 4 absent, 7 apparently connate with 6, anastomosing with 8 to near apex.

Type *maculicostella*, Rag. Besides the following, *actiosoides*, Hamps., from Ceylon, the type of *Mimistis*, Hamps., is referable here.

Aspithra denticornis, n. sp.

♂♀. 19–26 mm. Head, palpi, thorax reddish-brown to dark crimson-grey, terminal joint of palpi nearly as long as second. Antennae ♂ with strong flat-topped teeth (over 1), moderately ciliated. Fore-wings elongate, somewhat dilated, termen slightly oblique;

varying from red-brown to dull greyish-crimson, more or less speckled dark grey; lines slender, straight, white, both edged darker suffusion anteriorly only, sometimes much obscured or nearly obsolete, first from $\frac{1}{4}$ of costa to middle of dorsum, second at $\frac{4}{5}$, parallel to termen; discal spot represented by a slender oblique white bar, sometimes obsolete; a fine dark fuscous terminal line; cilia concolorous with wing, extreme base whitish. Hind-wings varying from whitish-ochreous to grey; cilia whitish-ochreous, sometimes faintly rosy-tinged.

Marquesas, Hiva Oa, Fatu Hiva, to 3500 feet, December, January; 106 ex. Very variable in colour and distinctness of marking; the characteristic antennae are a peculiar feature.

Aspithra maculicostella, Rag.

♂. 12–14 mm. Head, thorax pale pinkish-ochreous, variably sprinkled grey and white. Palpi grey sprinkled darker and whitish, terminal joint as long as second or longer. Fore-wings elongate, posteriorly dilated, termen somewhat oblique; pinkish-ochreous, irregularly irrorated dark grey, more or less irrorated white except towards dorsum; first line straight, oblique, more or less suffused white, usually obsolete on dorsum, sometimes edged dark fuscous anteriorly, preceded in disc by a suffused blackish blotch or spot; beyond this a triangular dark fuscous median costal blotch reaching half across wing, more blackish in disc, space between this and second line usually suffused whitish; second and subterminal lines only represented by obscure ill-defined darker grey shades; cilia whitish-grey, a grey subbasal shade. Hind-wings light grey; cilia grey-whitish, a grey subbasal shade.

Marquesas, Nuka Hiva, Tahuata, to 500 feet, January; 29 ex.

Aspithra dryinandra, n. sp.

♀. 22–23 mm. Head white, a few fuscous scales. Palpi rosy-brownish sprinkled black, apex of second joint white, terminal joint as long as second or longer, variably sprinkled or suffused white. Thorax white, collar and tegulae more or less suffused rosy-brownish and sprinkled black. Fore-wings elongate, posteriorly slightly dilated, termen somewhat oblique; white, irregularly sprinkled black; first line broad, straight, oblique, clear white on upper half, preceded on this part by thick irregular dark fuscous marking and followed by a triangular dark fuscous costal blotch, posterior margin of line irregularly suffused light rosy-brownish; beyond costal blotch an annular white discal spot centred black, its lower extremity forming a short posterior tooth, above which is sometimes a black mark; second line thick, indented towards costa and towards dorsum, edged with two strong dark fuscous lines, anterior more or less suffused light rosy-brownish; a terminal series of black dots; cilia light grey or brownish, a suffused series of darker grey spots. Hind-wings pale ochreous-greyish; cilia whitish-ochreous.

♂. 16–19 mm. Head, palpi, thorax mostly suffused brownish or fuscous. Fore-wings suffused brown, irrorated blackish; dark fuscous markings as in ♀ visible but more or less indistinct; only in one example (out of seven) the whitish ground-colour and first line partially developed and the white discal spot distinct; hind-wings greyer, sometimes minutely speckled.

Marquesas, Hiva Oa, 3500 feet, January; 23 ex. (7 ♂, 16 ♀).

Aspithra chrysura, n. sp.

♂♀. 15–18 mm. Head, palpi, thorax grey, terminal joint of palpi longer than second, slender, acute. Abdomen whitish-ochreous, ♂ with orange genital tufts. Fore-wings elongate, rather dilated, termen somewhat obliquely rounded; grey sprinkled darker; lines obscure, grey-whitish, slightly irregular, first rather oblique, edged posteriorly dark fuscous suffusion, second slightly sinuate, slightly indented towards costa, edged anteriorly dark fuscous suffusion; a small dark fuscous discal spot; cilia whitish-grey. Hind-wings whitish-grey; cilia grey-whitish, a grey subbasal line.

Marquesas, Nuka Hiva, Hiva Oa, to 300 feet, January, February; 3 ex.

Phycita orthoclina, n. sp.

♂♀. 17–20 mm. Head, palpi, thorax grey somewhat sprinkled white, palpi terminal joint short. Fore-wings elongate, posteriorly dilated, termen little oblique, grey irregularly irrorated white, sometimes sprinkled dark fuscous; first line whitish, slightly irregular, straight, oblique, edged posteriorly dark fuscous suffusion, some reddish-grey suffusion about fold beyond this; two dark fuscous dots somewhat obliquely placed on angles of cell; second line whitish, edged both sides fuscous, slightly waved, slightly excurved on median third and indented above and below this, seldom an obscure streak of dark suffusion from above upper indentation to plical suffusion of first line; cilia greyish with rows of white points. Hind-wings light greyish, terminal edge grey; cilia pale greyish, a grey subbasal line.

Marquesas, Hiva Oa, Nuka Hiva, Tahuata, to 1200 feet, December, January; 15 ex.

Etiella drososcia, n. sp. .

♂♀. 20–24 mm. Head, palpi, thorax whitish-grey, maxillary palpi ♂ whitish-yellowish. Fore-wings light grey, speckled whitish and more or less sprinkled darker grey, sometimes rosy-tinged; a moderate white costal stripe from near base to near apex, more or less sprinkled grey, usually suffused grey towards costa on posterior half or costal edge wholly dark grey; first line represented by an obscure pale pinkish-ochreous shade on dorsal ⅔, preceded by three small raised dark grey spots with some submetallic grey scales; two small indistinct darker grey spots transversely placed on end of cell; second line sometimes indicated by a series of cloudy dark grey marks on veins; a cloudy darker interrupted terminal line; cilia whitish-grey. Hind-wings grey-whitish, sometimes greyer towards apex; terminal edge grey; cilia whitish.

Society Is., Tahiti, February to August (*Miss Cheesman, Collenette*); 7 ex.

Homoeosoma inexplorata, n. sp.

♂♀. 13–17 mm. Head, thorax grey more or less mixed or suffused white. Palpi grey, extreme tip white. Fore-wings elongate, narrow at base, gradually dilated, termen obliquely rounded; 4 and 5 long-stalked; grey, irregularly sprinkled white and darker grey; first line indicated by an oblique dark grey streak from costa, a small spot in disc, and another towards dorsum, forming an angulated series; two similar spots on angles of cell, and one beyond them on costa; an obscure whitish subterminal line more or less indicated, indented above middle, edged anteriorly darker grey suffusion; cilia grey-whitish. Hind-wings grey-whitish, terminal edge grey; cilia whitish.

Society Is., Tahiti (*Miss Cheesman, Collenette*); Austral Is., Rurutu; Rapa; March, April, 22 ex. An obscure species, probably allied to *amphibola*.

CTENOMERISTIS, n. g.

Tongue well-developed. Antennae ♂ unipectinated, apical third simple, scape stout, with slight apical tooth. Labial palpi moderate, curved, ascending, second joint thickened with dense scales, terminal joint as long or shorter, scaled, obtuse-pointed. Maxillary palpi short, filiform, porrected. Fore-wings 2 from towards angle, 3–5 approximated at base, 8 and 9 stalked, 10 approximated. Hind-wings 3 from angle, 4 and 5 stalked almost from point with 3, 7 connate with 6, closely appressed to 8 to near middle.

Type *almella*, Meyr., from Australia; this is placed by Ragonot in his genus *Odontarthria*, which however is founded on a Brazilian (?) species which has 4 and 5 of fore-wings stalked.

Ctenomeristis ochrodepta, n. sp.

♂♀. 18–20 mm. Head, palpi fuscous mixed whitish. Antennae ♂ with apical sixth simple, scape without tooth. Thorax whitish-fuscous sprinkled darker. Fore-wings elongate-triangular, termen little oblique; whitish-fuscous irrorated fuscous, sometimes white-sprinkled towards costa; first line white, oblique, indistinct towards dorsum, followed on costa by a triangular dark fuscous blotch suffused posteriorly; two small dark fuscous spots transversely placed on angles of cell; second line at $\frac{2}{3}$, white, waved, slightly excurved in disc, edged dark fuscous suffusion on both sides, from this towards costa an obscure irregular fuscous shade directed towards middle of dorsum more or less developed; a terminal series of dark fuscous marks; cilia light greyish-ochreous or greyish. Hind-wings ochreous-fuscous, darker towards termen; cilia whitish-grey-ochreous, a grey subbasal shade.

Marquesas, Hiva Oa, Nuka Hiva, Tahuata, to 850 feet, December, January; 144 ex.

Cateremna albicostalis, Walk. (*niveicostella*, Hamps.).

Marquesas, Nuka Hiva, January; 1 ex. Also from Ceylon, Assam, Queensland.

Cateremna halmophila, n. sp.

♂♀. 18–22 mm. Head, palpi, thorax light grey. Fore-wings elongate, posteriorly dilated, termen somewhat obliquely rounded; light lilac-grey sprinkled darker, broadly suffused white towards costa except near base and apex, and sprinkled white towards termen; first line faintly whitish, rather oblique, sinuate in disc, edged rather dark fuscous posteriorly, more strongly and distinctly on upper half; two small rather dark fuscous spots transversely placed on angles of cell; second line at $\frac{2}{3}$, faint, whitish, waved, hardly excurved in disc, obscurely darker-edged, followed on costa by a spot of dark fuscous suffusion; a terminal series of dark fuscous dots; cilia grey-whitish. Hind-wings whitish-grey; a grey terminal line; cilia whitish.

Marquesas, Hiva Oa, Tahuata, Fatu Hiva, to 850 feet, December, January; Society Is., Raiatea, May (*Miss Cheesman*); 26 ex.

Acrobasis ptilophanes, n. sp.

♂. 24–25 mm. Head, palpi, thorax lilac-brown. Antennae flat-dentate, with broad naked basal sinuation, scape with strong obtuse horny projection above. Posterior tibiae with long dense pale rosy-ochreous hairpencil from base above. Fore-wings elongate, posteriorly dilated, termen somewhat obliquely rounded; purplish-fuscous; first line represented by two or three small irregular ochreous-whitish spots in disc; two small dark fuscous spots transversely placed on end of cell, sometimes some whitish-ochreous suffusion round these; second line at $\frac{2}{3}$, straight, slightly waved, grey-whitish, edged dark suffusion anteriorly; a terminal series of dark fuscous dots, edged grey-whitish suffusion anteriorly: cilia purplish-fuscous. Hind-wings grey; cilia light rosy-grey.

♀. 25 mm. Head, palpi, thorax light grey. Antennae and legs without special structures. Fore-wings fuscous, paler and whitish-tinged towards costa anteriorly; first line indicated by a dark grey suffused triangular blotch following it on costa; spots on end of cell and second line as in ♂; an interrupted dark fuscous terminal line; cilia grey. Hind-wings and cilia grey.

Society Is., Tahiti, 1500 feet, March; 3 ex. (2 ♂, 1 ♀).

Eurhodope ardescens, n. sp.

♂♀. 12–16 mm. Head, palpi, thorax grey, sometimes slightly reddish-tinged. Fore-wings elongate, posteriorly dilated, costa gently arched, termen somewhat oblique; 3 from well before angle, 4 and 5 connate; grey or dark grey, more or less crimson-tinged, especially basal area, sometimes slightly sprinkled whitish; first line moderately thick, straight, oblique, white, sometimes indistinct, edged posteriorly with a thick streak of dark fuscous suffusion; two cloudy dark dots on angles of cell sometimes visible, often obsolete; second line at $\frac{2}{3}$, cloudy, whitish, somewhat indented above middle and towards dorsum; an irregular cloudy whitish praemarginal shade; cilia whitish-grey. Hind-wings cell reaching $\frac{2}{3}$, 3–5 approximated at base; light grey; a dark grey terminal line; cilia grey-whitish, greyer towards base.

Society Is., Tahiti (to 1500 feet), Raiatea (*Miss Cheesman*); Austral Is., Rurûtu (to 650 feet); Rapa (to 800 feet); February to May, 52 ex.

Galleriidae.

Meliphora grisella, Fabr.

Society Is., Tahiti, May (*Miss Cheesman*); 1 ex. Cosmopolitan and domestic, the larva feeding on dried fruits, etc.

Pyralidae.

Endotricha mesenterialis, Walk.

Society Is., Tahiti; Austral Is., Rurutu, to 650 feet; February, March, 17 ex. Also from Java, Queensland, Samoa, Kermadecs (other records uncertain). Distinguished from all other species of the genus by the long pointed chitinous horn projecting above at right angles from apex of scape in ♂, longer than scape itself.

Herculia repetita, Butl.

Society Is., Tahiti, February; 3 ex. Also from Queensland, New Guinea, Solomon Is.

PYRAUSTIDAE.

Aulacodes eupselias, n. sp.

♂. 21 mm. Head, palpi, thorax light grey mixed whitish. Antennae ciliations 1½. Abdomen grey, anal tuft white. Fore-wings very elongate-triangular, termen somewhat oblique; 10 separate, approximated to 8 on basal half; fuscous-grey; a somewhat oblique violet-whitish fascia from dorsum before ⅓, reaching more than half across wing; a somewhat oblique violet-whitish streak from middle of dorsum to cubitus, its apex expanded posteriorly into a pear-shaped blotch; a violet-whitish fascia from costa at ⅔ directed towards tornus but only reaching ⅔ across wing (cilia injured). Hind-wings fuscous-grey; a whitish blotch at base, a fascia at ⅓, and irregular suffusion occupying disc posteriorly, a fine irregular dark fuscous line nearly preceding subterminal fascia; a curved black subterminal fascia including five elongate white marks.

MARQUESAS, Tahuata, 850 feet, January; 1 ex.

Bradina tormentifera, n. sp.

♂♀. 24–27 mm. Head, thorax white, partly tinged ochreous, shoulders dark fuscous. Palpi dark fuscous, basal joint and oblique lower half of second white. Abdomen white, a dorsal series of triangular dark fuscous spots. Fore-wings rather elongate-triangular, termen rather obliquely rounded; white; a narrow dark fuscous streak running round costa and termen; lines thick, dark fuscous, first at ⅛, direct, slightly curved, from this a suffused dark fuscous streak runs along vein 1*b* to tornus, second from costa before ¾ to dorsum near tornus, excurved on lower ⅔ and somewhat sinuate near costa; small round orbicular and narrow transverse discal spot dark fuscous, resting on costal streak; suffused dark fuscous lines on veins 2–4 as far as second line, and short lines on all veins towards termen diminishing downwards; cilia white or light grey, a fuscous subbasal line. Hind-wings white; a dark fuscous arrowhead-shaped discal spot; second line thick, dark fuscous, strongly excurved or bent in middle; slender terminal streak and cilia as in fore-wings.

MARQUESAS, Hiva Oa, 3500 feet, January; 39 ex. Allied to *perlucidalis*.

Bradina perlucidalis, Hamps.

MARQUESAS, Hiva Oa, Fatu Hiva, Tahuata, to 2000 feet, December, January; 24 ex.

Tatobotys vibrata, n. sp.

♂. 25–26 mm. Head grey or dark fuscous, crown suffused pale ochreous or rufous. Palpi greyish-ochreous or fuscous, basal and second joints with dense projecting scales anteriorly, terminal joint minute. Thorax greyish or dark purplish-fuscous. Abdomen ♂ anal segment normal. Fore-wings elongate-triangular, costa faintly sinuate, termen obliquely rounded; fuscous or dark purplish-fuscous; lines dark fuscous, edged externally whitish-ochreous, first before ¼, rather curved, second about ⅔, waved, upper third excurved, median third broken outwards, then abruptly indented to beneath discal spot; spots dark fuscous, orbicular small or dot-like, discal annular, followed or surrounded by whitish-ochreous suffusion sometimes extended to first line; a terminal series of dark fuscous elongate or lunulate marks; cilia light grey. Hind-wings fuscous or purplish-fuscous; discal spot dark fuscous surrounded by more or less pale suffusion; second line, terminal marks, and cilia as in fore-wings.

MARQUESAS, Hiva Oa, 3500 feet, January; 2 ex.

Tatobotys biannulalis, Walk.

Society Is., Tahiti (1500 feet), Raiatea (*Miss Cheesman, Collenette*); Austral Is., Rapa; March to May, 19 ex. Also from Fiji, New Hebrides, Sula, Borneo.

PYTHAGORAEA, n. g.

Head shortly rough-haired on crown, face smooth, rounded; tongue strong. Antennae ♀, ♂ slender, serrulate. Labial palpi rather short, subascending, second joint shortly rough-scaled beneath, terminal joint short, naked, pointed-conical. Maxillary palpi short, filiform, porrected. Legs slender, posterior tibiae with outer middle-spur nearly half inner. Fore-wings 3–5 approximated at base, 9 and 10 out of 8. Hind-wings 3–5 approximated at base, 7 out of 6 near origin, anastomosing with 8 to near middle. (Abdomen ♂ missing, probably elongate.)

Probably allied to *Dracaenura*.

Pythagoraea categorica, n. sp.

♂♀. 21–22 mm. Head brownish, face dark fuscous. Palpi fuscous, basal joint and lower part of second white. Thorax dark purplish-fuscous. Fore-wings elongate-triangular, costa faintly sinuate, termen bowed, rather oblique; dark fuscous, slightly purplish-tinged; spots white, orbicular dot-like, discal transverse-linear; a narrow straight white fascia from costa at ⅔ to tornus (cilia missing). Hind-wings dark fuscous, slightly purplish, without markings.

Society Is., Tahiti, 500 feet, March, July (*Miss Cheesman, Collenette*); 2 ex.

Hellula undalis, Fabr.

Society Is., Raiatea, May (*Miss Cheesman*); 1 ex. Practically cosmopolitan in warm regions.

Piletocera signiferalis, Wall.

Marquesas, Fatu Hiva, Nuka Hiva, Tahuata; Society Is., Tahiti, Raiatea, Bora-Bora (*Miss Cheesman, Collenette*); Moorea; Austral Is., Rurutu, Rapa; January to April, 62 ex. Also from Fiji, Ellice, and Caroline Is.

Hymenia fascialis, Cram.

Marquesas, Tahuata; Society Is., Tahiti (*Miss Cheesman, Collenette*); Austral Is., Rapa; January to April; 18 ex. Cosmopolitan in warm regions.

Eurrhyparodes tricoloralis, Zell.

Austral Is., Rurutu, March; 1 ex. Widely distributed through Australia, the Indo-Malayan region, and Africa.

Hydriris ornatalis, Dup.

Society Is., Tahiti, February, March; 2 ex. Practically cosmopolitan in warm regions, but apparently not hitherto recorded from the Pacific islands.

Marasmia hemicrossa, Meyr.

Society Is., Tahiti (to 2500 feet), Moorea (to 1000 feet); Austral Is., Rapa; March, April (*Miss Cheesman, Collenette*); 38 ex. Originally described from Tahiti.

Marasmia trapezalis, Guén.

Marquesas, Hiva Oa, Fatu Hiva, Nuka Hiva, Tahuata; Society Is., Tahiti, Raiatea, Bora-Bora (*Miss Cheesman, Collenette*); Paumotus, Napuka; Austral Is., Rurutu; Rapa; December to June, 55 ex. Cosmopolitan in warm regions.

Marasmia venilialis, Walk.

Society Is., Tahiti (to 1500 feet), Bora-Bora (*Miss Cheesman, Collenette*); Austral Is., Rurutu; February to July; 8 ex. Ranges from Africa through the Indo-Malayan region and Australia to Fiji.

Syngamia floridalis, Zell.

Society Is., Tahiti, to 1500 feet, March; 5 ex. Also ranges from Africa through the Indo-Malayan region and Australia to the New Hebrides.

Omiodes diemenalis, Guén.

Society Is., Tahiti, Raiatea, Bora-Bora (*Miss Cheesman, Collenette*); Austral Is., Rurutu; March to June; 21 ex. Ranges from Africa through the Indo-Malayan region and Australia to Fiji.

Margaronia uranoptris, n. sp.

♀. 30 mm. Head white, lower part of face pale ochreous, orbits behind eyes orange. Palpi light golden-ochreous, towards base white beneath. Thorax pearly-white, shoulders orange. Fore-wings elongate-triangular, termen rounded, rather oblique; thinly scaled violet-blue-whitish; an ochreous costal streak from base to $\frac{1}{3}$, a rather oblique greyish line from end of this to cubital vein; first line greyish, rather oblique, bent in middle, ochreous on costa; costa suffused pale ochreous from before middle to apex, two small ochreous spots beneath this before and beyond middle; a greyish-purple terminal fascia occupying $\frac{1}{4}$ of wing, suffused yellow-ochreous on costa, termen, and tornus, and slenderly on veins; a blackish-grey terminal line; cilia grey with white reflections. Hind-wings ground-colour and terminal band as in fore-wings, latter narrowed below middle and not reaching tornus, its narrow portion preceded by a dark grey line; a grey mark near tornus; cilia white, on a short space below middle with a dark fuscous subbasal line.

Society Is., Tahiti, 2500 feet, March; 1 ex.

Margaronia psammocyma, n. sp.

♂♀. 30–32. Head white, crown more or less grey centrally. Palpi grey, basal $\frac{3}{4}$ of basal joint and basal half of second white. Thorax grey, edges of collar white. Abdomen grey, segmental margins more or less marked white, anal tuft ♂ blackish with white central bar and preceded by a white spot. Fore-wings elongate-triangular, termen obliquely rounded; dark grey; markings cloudy, obscure, dull light ochreous-yellowish, easily abraded; first line thick, irregular, rather oblique, three more irregular similar lines

between this and base; beyond this a transverse fascia enclosing pale dark-edged orbicular, sometimes preceded and followed by small whitish spots; discal spot composed of two irregular transverse streaks enclosing a dark streak, with a longitudinal mark above it, and connected with dorsum by an irregular sinuate streak; beyond this a moderate fascia cut by veins into longitudinal spots, one or two of these beyond discal spot sometimes whitish; second line pale edged dark, dentate, from $\frac{4}{5}$ of costa to near tornus, then with very strong indentation on fold to dorsum at $\frac{4}{5}$, preceded on upper half by a narrow fascia, and terminal area beyond it wholly pale except a thick terminal line; cilia grey. Hind-wings grey, basal half suffusedly tinged whitish-yellowish, a dark grey transverse discal spot, posterior area with 3 or 4 narrow somewhat curved fasciae of whitish-yellowish suffusion converging downwards to near tornus; cilia whitish, a grey subbasal shade.

Society Is., Tahiti, 1500 feet, March; 4 ex. An obscure insect of dusky appearance and confused markings.

Margaronia multilinealis, Kenr.

Proc. Zool. Soc. Lond., 1907, 83, pl. iv.

Society Is., Tahiti, 1500 feet, March; 2 ex. Also from New Guinea and Samoa.

Thliptoceras octoguttalis, Feld.

Society Is., Tahiti, 1500 feet, March; 1 ex. Ranges from Africa through Indo-Malayan region to Australia. The specimen resembles Brisbane examples rather than those from more tropical latitudes, the hind-wings being almost wholly orange except a dark subterminal fascia.

Maruca testulalis, Hübn.

Marquesas, Hiva Oa (to 3500 feet), Tahuata (bred from larva No. 33), Nuka Hiva, Fatu Hiva; Society Is., Tahiti (to 1500 feet), Moorea, Raiatea (*Miss Cheesman, Collenette*); Austral Is., Rurutu; December to May; 84 ex. Occurs in hot regions throughout the world.

Diasemia ramburialis, Dup.

Society Is., Tahiti, August (*Miss Cheesman*); Austral Is., Rapa, April; 9 ex. Ranges from S. Europe to Africa, S. Asia, Australia, N. America; occasionally found in England, and clearly a great wanderer.

Pachyzancla stultalis, Walk.

Marquesas, Hiva Oa, 1200 feet, January; 1 ex., a small ♀. Ranges from Madagascar through the Indo-Malayan region to Australia.

Hampson (*Proc. Zool. Soc. Lond.*, 1899: 201) defines *Pachyzancla*, Meyr., as having the palpi porrect, triangularly scaled, the third joint hidden by hair, and places it in his tabulation by the same characters; these may apply to some of the species he includes in the genus, but by no means to *stultalis*, which is the type of the genus, and was described by me in 1884 as having the palpi ascending, the terminal joint conical, exposed; I still possess the specimens described, and the description is unquestionably correct, and applies equally to my examples from other regions.

Psara licarsialis, Walk.

Society Is., Tahiti, Raiatea (*Miss Cheesman, Collenette*); Austral Is., Rurutu; Rapa, February to April; 25 ex. Occurs also in Indo-Malayan region, Australia, Fiji, Samoa, Marshall Is.

Mecyna aureolalis, Led.

Society Is., Tahiti, 1500 feet, March; 1 ex. Occurs also in India, Ceylon, Burma, Andaman Is.

Calamochrous thermochra, n. sp.

♂♀. 33–37 mm. Head, thorax ferruginous-ochreous. Palpi ochreous. Fore-wings rather elongate-triangular, termen rounded, oblique; yellow-ochreous, suffusedly irrorated ferruginous; lines fuscous, first angulated in middle, second at $\frac{2}{3}$, upper $\frac{2}{3}$ waved, sinuate, then abruptly broken inwards to beneath discal spot, thence straight to dorsum; spots fuscous, orbicular small, round, discal transverse; cilia rather dark fuscous. Hind-wings and cilia whitish-ochreous.

Society Is., Tahiti, 1500–2500 feet, March; 2 ex.

Idioblasta, Warr.

Face smooth, rounded; tongue developed. Antennae $\frac{3}{4}$, ♂ minutely ciliated. Labial palpi moderately long, porrected, clothed with dense loose hairscales attenuated to apex, terminal joint short, obtuse-pointed, depressed. Maxillary palpi moderately porrected, scales expanded towards apex. Posterior tibiae with outer middle-spurs nearly as long as inner. Fore-wings 8 to termen. Hind-wings 3 and 4 short-stalked, 5 absent, 7 connate with 6, connected with 8 at a point or very shortly near base only.

Type *lacteata*, Warr.

Hampson merged this in *Pionea*, but it is quite a distinct genus; Warren's description, however, is quite inadequate, as he paid no attention to neuration, and I have therefore redescribed it.

Idioblasta lacteata, Warr.

Marquesas, Nuka Hiva, at light on ship in harbour, January; 1 ex.

Idioblasta straminata, Warr.

♂♀. 16–20 mm. Head, palpi, thorax, abdomen ochreous-yellowish. Fore-wings somewhat elongate-triangular, termen rounded, somewhat oblique; light ochreous-orange; three short fine blackish dashes from base; three slender blackish lines, first about $\frac{1}{4}$, irregular, ill-defined, very sharply dentate outwards above middle and incurved below this, second before middle, somewhat irregularly curved, sometimes rather angular above and below middle, third from costa at $\frac{2}{3}$ to dorsum before tornus, slightly irregularly curved or nearly straight; a blackish terminal line; cilia pale orange. Hind-wings light ochreous orange; a subdorsal blackish streak attenuated or obsolete anteriorly; a large blackish apical blotch; cilia light orange, round apex a dark grey shade. Fore-wings beneath with broad blackish fascia from costa at $\frac{2}{3}$ to near tornus but not quite reaching it, narrowest on costa.

Marquesas, Hiva Oa, 3500 feet, December, January; 20 ex. I have no doubt that this is Warren's *straminata*, but the description is imperfect and incorrect; I have therefore redescribed it.

Isocentris illectalis, Walk.

Austral Is., Rapa, April; 1 ex. An Indo-Australian species, doubtless artificially introduced.

Pyrausta phthorosticta, n. sp.

♂♀. 26–32 mm. Head, thorax whitish-ochreous. Palpi fuscous, beneath white towards base, upper edge whitish-ochreous. Abdomen whitish, 3 basal segments each with two blackish dots, 4–7 each with single less marked fuscous dots, 8 with three dark fuscous dots, genital tufts ♂ long, ochreous-yellowish. Fore-wings rather elongate-triangular, termen bowed, oblique; 10 closely appressed to stalk of 8 and 9 on basal half; ochreous-whitish, tinged fuscous along costa, some slight irregular infuscation about veins; extreme costal edge blackish; an angular black dot on base of costa; a black dot near costa beyond this, one near base below middle, and one on dorsum towards base; first and second lines represented by irregularly angulated series of dark fuscous marks; orbicular dot-like, black, discal spot small, transverse, black, sometimes pale-centred; subterminal cloudy, light fuscous, dentate, median third excurved, preceded by two dark fuscous dots (really an outwards-broken segment of second line); a terminal series of elongate black dots, preceded by a dentate line of faint cloudy infuscation; cilia whitish-ochreous. Hind-wings ochreous-whitish; a black discal dot; second line median, formed by a subconnected series of blackish lunate spots, median third abruptly broken outwards and preceded by fuscous suffusion, subterminal as in fore-wings; a terminal series of black dots, alternating with series of submarginal cloudy grey spots; cilia whitish-ochreous.

Marquesas, Hiva Oa, 3500 feet, January; 10 ex.

Scoparia citrocosma, n. sp.

♂♀. 18–20 mm. Head, palpi, thorax pale yellow, variably sprinkled black, basal half of tegulae sometimes black, maxillary palpi with two black bars. Fore-wings narrow at base, posteriorly dilated, termen somewhat oblique; pale yellow, irregularly irrorated black; lines clear pale yellow, first rather oblique, slightly irregular, preceded and followed by more or less black suffusion on upper half, second strongly excurved on median third, subterminal rather thick, irregular, incurved and confluent with second in middle; spots black, partly margined pale yellow, claviform small, rounded, not touching first line, orbicular similar, rather beyond this, discal X-shaped, space between these forming a small pale yellow spot; spaces beyond and between second and subterminal lines wholly black; cilia pale yellow, an interrupted black subbasal line, beyond this barred dark grey. Hind-wings light greyish, termen suffused darker grey; cilia whitish-grey, a dark grey subbasal line.

Marquesas, Hiva Oa, 3500 feet, January; 21 ex.

Scoparia chrysomicta, n. sp.

♂♀. 16–18 mm. Head, thorax dark fuscous mixed ochreous-yellowish and partially with white. Palpi dark grey, white towards base beneath, apex of maxillary palpi white. Fore-wings narrow at base, posteriorly dilated, termen somewhat oblique; dark fuscous or blackish, irregularly mixed ochreous-yellow or yellow-ochreous; lines white, first irregular, rather oblique, second at $\frac{1}{3}$, excurved in disc, subterminal irregular, partly thick, more or less interrupted in middle, lower part sometimes touching second; spots black, ill-defined, claviform oval or roundish, lying in a streak of white suffusion joining first and

second lines, orbicular small, beyond this, connected with discal by a spot of white suffusion, discal obscurely 8-shaped, upper half filled yellow-ochreous, lower yellow-ochreous or white; a slight streak of white irroration beneath median part of costa; a transverse blotch of white suffusion preceding upper part of second line; cilia dark grey barred white suffusion, a dark fuscous subbasal line. Hind-wings grey, termen suffused darker grey, more broadly towards apex; cilia pale greyish, a dark grey subbasal shade.

MARQUESAS, Hiva Oa, 3500 feet, January; 29 ex.

Scoparia clerica, n. sp.

♂♀. 14–17 mm. Head, thorax white more or less mixed blackish. Palpi dark grey, towards base beneath and apical edge white. Fore-wings elongate, posteriorly dilated, termen somewhat oblique; white rather thinly sprinkled blackish; an oblique irregular blackish streak from base of costa reaching half across wing; first line white, rather oblique, obtusely angulated above middle, edged posteriorly black irroration sometimes forming a spot on costa; orbicular and claviform represented by elongate marks of blackish suffusion or claviform sometimes round, superposed, discal 8-shaped, white, more or less completely outlined black, upper half in one example partly tinged yellowish; second line white, somewhat excurved in disc, subterminal represented by two white macular blotches, lower touching second line in middle, terminal area enclosing these dark fuscous except a crenate white terminal line; cilia white, a dark grey subbasal line, outer area barred grey. Hind-wings grey, darker towards termen; cilia whitish-grey, a dark grey subbasal line.

MARQUESAS, Hiva Oa (3500 feet), Fatu Hiva (2000 feet), January; 13 ex.

Scoparia spectacularis, n. sp.

♂♀. 13–15 mm. Head, thorax fuscous mixed ochreous-whitish. Palpi dark fuscous, whitish towards base beneath, apex of maxillary palpi whitish. Fore-wings elongate, posteriorly dilated, termen somewhat oblique; fuscous mixed ochreous-whitish, somewhat sprinkled black; a thick oblique irregular black streak from base of costa reaching half across wing, terminating in an elongate spot; lines white or ochreous-white, first and second slender, first little oblique, bent above middle, edged blackish suffusion posteriorly, more strongly towards costa, second excurved in disc, edged anteriorly by black costal spot, subterminal interrupted into two macular blotches, lower touching second line in middle, area round these blackish; claviform large, oval, black, nearly touching first line, orbicular elongate, black, superposed, discal 8-shaped, outlined black, often imperfect beneath, upper half light ochreous-yellowish sprinkled dark fuscous, lower whitish sprinkled fuscous; a terminal series of white dots; cilia white, a dark fuscous subbasal line, beyond this barred or sometimes suffused grey. Hind-wings rather dark grey; cilia pale grey, a darker subbasal shade.

MARQUESAS, Hiva Oa (3500 feet), Fatu Hiva (2000 feet), January; 30 ex.

Scoparia commercialis, n. sp.

♂♀. 15–17 mm. Head, thorax dark grey, a few black and white scales. Palpi grey, white towards base beneath, apex of maxillary palpi mixed white. Fore-wings elongate, posteriorly dilated, termen somewhat oblique; dark grey, irregularly mixed white, pale yellowish, and blackish; a suffused black oblique streak from base of costa reaching half across wing, and elongate dorsal spot near base; lines moderate, white, somewhat irregular, first rather oblique, second excurved on discal third or almost angulated; spots black,

claviform oval, orbicular small, round, above posterior end of claviform, sometimes connected with a dot preceding it, discal obscurely X-shaped; subterminal line ill-defined, of whitish irroration, more or less interrupted and lower part touching second line in middle; a terminal series of black dots; cilia light grey obscurely barred white, a dark grey subbasal shade. Hind-wings grey, darker towards apex; cilia whitish-grey, a grey subbasal line.

MARQUESAS, Hiva Oa, 3500 feet, January; 12 ex.

Scoparia officialis, n. sp.

♂♀. 13–15 mm. Head, thorax dark fuscous, a few whitish scales. Palpi fuscous, white towards base beneath, apex of maxillary palpi white. Fore-wings elongate, posteriorly dilated, termen rather obliquely rounded; dark fuscous, irregularly mixed light yellowish and white; subcostal, median, and dorsal elongate black spots near base, median posterior; first line slender, whitish, somewhat oblique, slightly curved, irregularly edged black posteriorly; rather large oval claviform and smaller roundish orbicular black, superposed, discal 8-shaped, only partly outlined black, often only median bar distinct; second line very fine, whitish, slightly denticulate towards costa, somewhat excurved in disc, edged black anteriorly; area beyond this black, enclosing two narrow well-defined whitish macular marks representing subterminal line, lower nearly or quite touching second line in middle, and a crenate ochreous-white terminal line; cilia grey, a dark grey subbasal line, base ochreous-white. Hind-wings dark grey; cilia grey, a dark grey subbasal line.

MARQUESAS, Hiva Oa, 3500 feet, January; 25 ex.

Scoparia opostactis, n. sp.

♂♀. 13–16 mm. Head, thorax fuscous, sometimes somewhat mixed whitish-ochreous. Palpi fuscous, ochreous-white towards base beneath. Fore-wings elongate, posteriorly dilated, termen rather oblique; fuscous, more or less sprinkled dark fuscous, sometimes mixed pale ochreous and yellowish; first line slender, ochreous-whitish, little oblique, slightly curved, edged dark fuscous posteriorly; spots dark fuscous, plical small, roundish or annular, orbicular smaller, beyond it, discal 8-shaped, imperfectly outlined blackish; second line fine, ochreous-whitish, slightly waved, excurved on median third, edged dark fuscous anteriorly; some undefined yellow-whitish suffusion towards termen representing subterminal line; a terminal series of black dots; cilia pale grey, a dark fuscous subbasal shade, base within this yellow-whitish. Hind-wings dark fuscous; cilia pale greyish, a dark grey subbasal shade.

MARQUESAS, Fatu Hiva, 2000 feet, January; 7 ex.

Scoparia philorphna, n. sp.

♂♀. 15–17 mm. Head, thorax grey mixed blackish. Palpi dark grey, white towards base beneath. Fore-wings elongate-triangular, termen rather oblique; grey, irregularly mixed black on veins, sometimes slightly mixed white; an oblique-triangular black spot on base of costa; lines slightly indicated with white, sometimes distinct towards costa, first followed by blackish costal blotch, slightly curved, somewhat oblique, second at $\frac{2}{3}$, rather excurved in disc, indented towards costa, preceded on costa by blackish suffusion, subterminal very indistinct, sinuate inwards above middle; spots cloudy, blackish, orbicular appearing elongate extended by blackish suffusion to touch first line, claviform rather small, touching first line, discal X-shaped; a terminal series of black dots; cilia

whitish-grey barred grey, a grey subbasal shade. Hind-wings rather dark grey, darker towards apex; cilia as in fore-wings.

Society Is., Tahiti, 1500–2500 feet, March; 10 ex., mostly in poor condition.

Scoparia chrysopetra, n. sp.

♂. 17 mm. Head ochreous-yellowish, forehead tinged grey, face white. Palpi fuscous, white towards base beneath, apex of maxillary palpi white. Thorax white. Fore-wings elongate-triangular, termen rather oblique; white, thinly and irregularly sprinkled blackish; a curved black subbasal fascia mixed ochreous-yellowish, leaving a small clear white median basal spot; first line thick, white, slightly oblique, irregular, indented in middle, edged posteriorly by blackish suffusion forming spots on costa and dorsum; spots rather large, undefined, formed of black and ochreous-yellow irroration, orbicular and claviform touching first line, discal well separated, touching second; second line thick, irregular, white, rather excurved on median third, indented above and below this; terminal area beyond this dark grey mixed blackish, subterminal line forming two spots of white suffusion, lower touching second line in middle; cilia white barred dark grey (imperfect). Hind-wings whitish-grey; an ill-defined terminal fascia of grey suffusion, darkest on termen, containing an obscure irregular macular whitish subterminal shade.

Society Is., Tahiti, 2500 feet, March; 1 ex. Though not in good condition, this is a very distinct species.

Scoparia exterminata, n. sp.

♂♀. 15–17 mm. Head, thorax grey mixed whitish. Palpi grey, basal joint and apical halves of the other two white. Fore-wings elongate-triangular, termen somewhat oblique; ochreous-whitish irrorated fuscous and dark fuscous; a small oblique-triangular blackish spot on base of costa, and an oval blackish spot near base in disc; lines whitish, first obscure, somewhat curved, followed on costa by a dark fuscous spot, second at $\frac{1}{5}$, nearly straight, direct, more or less edged anteriorly dark fuscous, obsolete on dorsum where there is sometimes a spot of dark fuscous suffusion, subterminal strongly sinuate inwards and touching second above middle, sometimes connected with upper portion of termen by several whitish bars, spots of dark fuscous suffusion between these; spots suffused, dark fuscous, undefined, orbicular small, or moderate, claviform obliquely before this, touching first line, discal sometimes obscurely X-shaped; cilia white mixed grey, a grey subbasal line. Hind-wings white, apical fourth suffused light grey; cilia white, a grey antemedian line round apical area.

Austral Is., Rapa, 800 feet, August; 3 ex.

Scoparia psednopa, n. sp.

♀. 15–18 mm. Head, thorax whitish-ochreous. Palpi 3, fuscous, white towards base beneath, apex of maxillary palpi white. Fore-wings very elongate-triangular, termen rather oblique; pale greyish-ochreous; a dark grey discal dot on end of cell, sometimes faint; second line sometimes faintly greyish towards costa, preceded and followed by white tinge on costal edge; subterminal line sometimes faintly whitish, sinuate, preceded by faint greyish sinuation; cilia white, base tinged ochreous within a greyish subbasal line. Hind-wings white, some slight grey suffusion at apex; cilia white.

Austral Is., Rapa, to 800 feet, April; 13 ex., at light, unfortunately without a ♂. This very obsoletely marked form is probably allied to the preceding, and has been adapted by loss of colouring to the open hill-side.

ON A GROUP OF MINUTE AUSTRALIAN *THYSANOPTERA* (TUBULIFERA) AND THEIR ASSOCIATION WITH THE SO-CALLED LEAF-GLANDS ON *ACACIA* *

By Richard S. Bagnall, D.Sc., F.R.S.E., F.L.S.

[Read June 5th, 1929.]

This memoir deals with a group of minute Australian thrips allied to the American Genera *Scopaeothrips* and *Rhopalothrips*, Hood. The group consists of the following genera and species :

Genus *Scopaeothrips*, Hood (species American).

S. unicolor, Hood, from *Opuntia*.

Genus *Rhopalothrips*, Hood (species American).

R. bicolor, Hood, from *Opuntia*.

Genus *Rhopalothripoides*, nov. (species Australian).

R. brunneus (Bagn.), from *Acacia dealbata* apparently frequenting leaf-glands.

R. kellyanus, sp. n., from *Acacia dealbata* with *R. brunneus*.

R. froggatti (Bagn.), from leaf-glands of *Acacia decurrens*.

Genus *Froggattothrips*, nov. (species Australian).

F. acaciae, sp. n., from Wattle (*Acacia*, sp.).

F. inconsequens, sp. n., from Wattle with *F. acaciae*, sp. n.

Biology.

From the list it will be seen that all the Australian species affect *Acacia*, and as the author is of the opinion that they are definitely associated with the so-called leaf-glands of the various species of *Acacia*, it will be well to examine such evidence as exists in support of this view before passing on to the description of new genera and species.

In June 1912 Mr. A. D. Hardy published a paper on " The Distribution of Leaf-glands in some Victorian Acacias " (*Vict. Nat.*, XXIX, p. 26), which was followed in Nov. 1913 by Mr. Reginald Kelly's " Observations on the Function of Acacia Leaf-glands " (*Vict. Nat.*, XXX, pp. 121–127).† In this latter paper, Kelly expresses doubt as to whether these excrescences were glands at all. He finds that though there is no mention of " glands " in respect of Acacias or any other plants in Strasburger (4th Eng. ed. 1912)—indeed the word is not even indexed—figure 174 (p. 168) depicts a seedling of *Acacia pycnantha*

* The title of this paper is cited and the five Australian species of *Rhopalothripoides* and *Froggattothrips* are named (without descriptions) in my Memoir " On Some New Genera and Species of Australian *Thysanoptera* (*Tubulifera*) with special reference to Gall-Species " (*Marcellia*, xxv, pp. 183–204, Portici 1929).

† See also Solereder, *Systematic Anatomy of Dicots*, Boodle and Fritsch, vol. 1, p. 296, 1908.

with phyllodes bearing nectaries, these " nectaries " being identical with the glands and the word itself fully confirmatory of a gland-like nature. Prior to seeing this illustration the author (Kelly) was, and is still, convinced that, whatever their function when on leaves these glands were mere survivals, obsolete and functionless on phyllodes.

Upon research Kelly was unable to find any secretion of a nectar or liquid nature even with the microscope. Uncut the glands have the appearance of firm, hollow warty excrescences with a central aperture protected by fine hairs, and in sectionally examined material fresh from trees not yet in flower the cavity is shown to have a hard dry inner wall hung with very beautiful minute crystals, the gland in the case of a species in flower being somewhat less dry or more succulent.

After discussing and dismissing various theories, Kelly writes on p. 125 *et seq.* as follows :—

" The three theories—symbiosis, fertilizing, and protective—may be considered together, as either a fertilizing or protective agency in this case would be intimately connected with insects and the symbiotic relation would be between the insects and the plant. . . . On many species that I have examined I have found insect life only in two—*Acacia baileyana* and *Acacia dealbata*—and this only by the aid of the microscope. They are extremely tiny creatures, the identification of which rests with entomologists. Most that I have observed are quite white and very active; some are brown. . . . They run in and about the crystals like people in streets. These insects are extremely difficult to dislodge, and, being visible only under the microscope, it is a work of art to get one for mounting. I have, so far, been unable to trace their life-history, except that on the crystals and the hairs outside I have found hanging their moulted skins. I found the insects first in March of this year; in April they were rarer. . . . I do not imagine for a moment that the Acacias grow these houses for the purpose of accommodating the insects, nor that charity is one of the attributes of plants. They, like every other form of life, are essentially selfish. Nor do they secrete delicacies for these insects; for whatever they secrete or exude they do for economic purposes and not benevolence. The large hollow thorns of *Acacia cornigera*, which are said to be inhabited by ants, are regarded as symbiotic structures, and it is generally accepted that mutual services are rendered by insects and plants. Some extra-Australian species are said to secrete sugary substance in their hollow thorns, and it is conceivable that the glands in our species are corresponding features aborted or modified. That insects only make use of them, taking them as they find them, is the more acceptable conclusion, until it can be shown that the organ is the common meeting-ground of the symbionts—that each one, if not essential, is at least beneficial to the other. Of this there is very little evidence. Most of the evidence is the other way. In the first place, it seems that only some of the glands are inhabited; some are almost solid. The insects are only in occupation at certain seasons. Many of the glands excrete their contents in the form of a floccus cap, which evidently loosens and falls away. The insects, if indeed, they remove the secretion at all, certainly feed upon the tissue of the gland and devitalize it. It is possible that the insect is injurious to the plant. It may be accepted as a fact that the plant is useful to the insect, but that there is no community of service. There is no evidence that the insect is a symbiont by virtue of any protection it affords; that there is any insect that it wards off, or that it could do so; or that, if it could, that the insect warded off would be any more injurious or less beneficial to the plant. There is no evidence that the insect is a fertilizing agent, or that the plant is entomophilous and not anemophilous. . . . At the same time it is probable that the insects are of some, if not great, value in keeping these organs clear of matter, with which they would otherwise be clogged. This service is doubtful, but, if real,

would be some indication of symbiosis. I come to the conclusion that these organs perform excretory functions, and are capable of performing them without outside aid—that they are not, strictly speaking, glands or nectaries, or, in other words, the terms gland and nectary do not accurately describe the nature of the growth. The secretions are neither fluid nor viscid. . . . These so-called glands (for which I suggest the name 'vents') in other forms may, in the earliest history of the genus, have performed other functions, and be now but reduced substitutes, or even aborted or non-developed stipules, whose work could be (and often is) otherwise performed. . . . As to the voluntary—or what in plants is believed by many to approximate to voluntary—accommodation by them of insects, I enjoy a delightful scepticism, which I should rejoice to destroy or confirm."

The minute insects he records from the "leaf-glands" or vents on *Acacia baileyana* are as yet undescribed, but those on *Acacia dealbata* are undoubtedly *Rhopalothripoides brunneus* and *R. kellyanus*, the white specimens being larvae. This, coupled with Froggatt's discovery of *R. froggatti* and its larvae in leaf-glands of *Acacia decurrens* not to mention the occurrence of two other allied species, *Froggattothrips* spp. on another species of *Acacia*, would seem to prove a definite relationship between these insects and *Acacia* leaf-glands, which is almost certainly symbiotic in character. Further, the minute form of the insect, its winglessness and its special chaetotaxy suggest a specialised habitat.

In regard to the N. American allies, both of which are found on Prickly Pear (*Opuntia*), Hood remarks (1912, *Proc. Biol. Soc. Washington*, XXV, p. 72): "In certain Phloeothripid genera, such as *Trichothrips*, Uzel, and *Allothrips*, Hood, whose species live under bark or in other secluded places, the ocelli are lacking in apterous or brachypterous generations and present in macropterous ones, while in the genera which constitute the main bulk of the family and whose species do not spend their lives in hidden places, the ocelli are always, and the wings usually, present. It is interesting to note, however, that the reduction of the eyes and the absence of ocelli cannot always be ascribed to a decrease in the light intensity, for this wingless species (*Rhopalothrips bicolor*) has no *ocelli* yet lives exposed to the rays of a tropical sun on the leaves of an intensely Xerophilous plant."

May it not be that these species too are normally inhabitants of glandular excrescences?

Systematic.

Minute species, truly wingless and without ocelli, having the intermediate abdominal segments strongly transverse and body setae strongly to exceptionally strongly dilated or infundibuliform.

Table of Genera.

1. Intermediate antennal joints longer and more slender, all segments free and of normal form. Fore legs in ♂ with inner margin of femur serrate and with a strong basal tooth and tibia dentiform near apex within. (A single American species, *S. unicolor*, Hood, found on *Opuntia*.)
Scopaeothrips, Hood.

Intermediate antennal joints shorter, joints 6–8 compactly united (as in *Cephalothrips*, Uzel, and *Dermothrips*, Bagn.). Fore femora and fore tibiae simple in both sexes . . . . . 2.

2. Body and antenna bicolorous. Antenna with joint 2 subglobose and conspicuously broad with 3 slender, so that both 2 and 4 are noticeably stouter in comparison. Body setae strongly infundibuliform. (A single American species, *R. bicolor*, Hood, found on *Opuntia*.)
Rhopalothrips, Hood.

Species unicolorous. Intermediate antennal joints of normal form. Body setae less strongly infundibuliform. Species Australian affecting *Acacia* . . . . . 3.

3. Head noticeably longer than the pronotum and pronotum strongly transverse (at least 2·25 times as broad as long) in both sexes. Mouth-cone broad, obconical, pointed at end; abdomen oblong ovate.
Rhopalothripoides, nov.

Head but slightly longer than the pronotum in the ♀ and shorter than the pronotum in the ♂; mouth-cone large and bluntly rounded at end; pronotum larger, twice or less than twice as broad as long and more greatly enlarged in ♂; abdomen broadly ovate . *Froggattothrips*, nov.

Genus **Rhopalothripoides**, nov.

Near *Rhopalothrips*, Hood; species minute; body short; head longer than the pronotum, broader than long and widest basally; mouth-cone obconical, sides straight, pointed at end; pronotum strongly transverse in both sexes; body bristles not strongly infundibuliform as in *Rhopalothrips*; body and antenna not varicoloured; antenna eight-segmented, of normal form with the three distal joints closely connected.

Type: *Rhopalothrips brunneus*, Bagn.

Chiefly separated from *Rhopalothrips* by the above characters: *Rhopalothrips* having the intermediate antennal joints distinctive, apart from coloration, in that joint 2 is subglobose and conspicuously wide, whilst 3 is very slender, so that 2 and 4 are noticeably broad in comparison.

The following is a table of the known species.

1. ♂ Length *c.* 0·75 mm. Pronotum 0·375 as long as broad; abdominal tergites very strongly transverse, 4 being nearly 7 times as broad as long; tube scarcely more than 0·5 the length of the head and nearly 0·8 as broad near base as long. Antennal joints 4 and 5 only slightly longer than broad. On *Acacia decurrens* . . . *R. froggatti* (Bagn.).

♀ Length 0·90–1·1 mm. Pronotum approximately 0·45 as long as broad; abdominal tergite less strongly transverse, about 4·4 to 4·6 times as broad as long. Tube longer as compared with the length of the head, and not so broad. Antennal joints 4 and 5 distinctly longer than broad. On *Acacia dealbata* . . . . . 2.

2. Somewhat larger and darker. Fore-coxal, pronotal and body setae markedly longer. Antennal joints longer and stouter. Abdominal segment 4 more than 0·5 the length of the head . . *R. brunneus* (Bagn.).

Smaller and lighter in colour; fore-coxal, pronotal and body setae markedly shorter. Antennal joints shorter and less stout, and abdominal segment 4 less than 0·5 as long as the head *R. kellyanus*, sp. n.

Rhopalothripoides kellyanus, sp. n.

♀. Length *c.* 0·9 mm. This species closely resembles *R. brunneus* (Bagn.), and the single example before me is mounted with the type of that species. I at first regarded it as a ♂ and upon finding that it was a ♀ I have made a close examination of the two forms. To the naked eye it is noticeably smaller than *R. brunneus* and also paler in colour, being of a uniform light brown,

whereas *brunneus* is of a deep blackish brown and was named *brunneus* as a distinction to *R. bicolor*. I hope that both sexes of both these species will be discovered, and in the meantime add a table of careful measurements of the known species.

Measurements in μμ.	♀ *brunneus*, Bagn.	♀ *kellyanus*, sp. n.	♂ *froggatti*. Bagn.
Length (and breadth):			
a. Head	150 (178)	130 (152)	112 (137)
b. Pronotum	120 (265)	100 (225)	75 (200)
c. Tube	88 (56 : 30)	82 (50 : 27)	58 (45 : 25)
d. Abdominal segment 4	80 (355)	60 (280)	37·5 (250)
Length of terminal hairs	62	62	35
Length of setae:			
Fore-coxal	29	21	15
Pronotal postero-angular	40	30	18
Long abdominal bristles on 9	68	62	50
Lateral abdominal setae on 7	40	30	18·5
„ „ „ 8	44	38	25
„ „ „ 9	44	34	25

Relative lengths (and breadths) of antennal joints 3–8 :—

R. kellyanus. ♀. 34 (25) : 35 (26·5) : 35 (25) : 37 (24) : 26·5 (17·5) : 16 (10) μ.
R. brunneus. ♀. 40 (26·5) : 40 (30) : 42 (28) : 42 (25) : 30 (18·5) : 20 (12) μ.
R. froggatti. ♂. 27·5 (21·5) : 27·5 (26) : 30 (27) : 29·5 (21) : 24 (16·5) : 15 (11) μ.

AUSTRALIA, Victoria, 1 ♀ on *Acacia dealbata* with ♀♀ of *R. brunneus* (*R. Kelly*).

Genus **FROGGATTOTHRIPS**, nov.

Species minute, wingless, and apparently related to *Rhopalothrips*, Hood.

Head strongly diverging posteriorly, where it is as broad as or broader than the length. Mouth-cone heavy, reaching across prosternum and bluntly rounded at end. Antenna with joint 3 roughly obconical, 4 to 6 constricted at base, and 6–8 broadly united much as in *Rhopalothrips* and *Rhopalothripoides*. Fore legs strongly incrassate and fore tarsus presumably armed. Pterothorax very short and as broad as width across fore coxae. Abdomen short and broad with segments 1–8 very strongly transverse, tube short. Body setae short and infundibuliform.

♂. Smaller, pronotum longer and fore legs more massive; fore tarsus armed with a large broad tooth.

TYPE : *Froggattothrips acaciae*, sp. n.

Table of Species, ♀♀.

Colour yellowish brown to brown; head longer, 155 (175) μ; tube 0·56 the length of head; fore-coxal and pronotal setae apparently longer and more strongly dilated . . . . . *F. acaciae*, sp. n.
Colour dark blackish brown; head shorter, 130 (175) μ; tube 0·75 the length of head; fore-coxal and pronotal setae apparently shorter and less strongly dilated . . . . . *F. inconsequens*, sp. n.

Froggattothrips acaciae, sp. n.

♀. Length *c*. 0·9 mm.; breadth of mesothorax 0·30 and of abdomen 0·39 mm.
Colour yellowish brown to brown, fore tibiae yellowish shaded to dark grey-brown

basally and laterally, and all tarsi yellowish. Antennae with joints 1 and 6–8 concolorous with head, 2 paler distally, 3 pale and 4 and 5 light grey-brown.

Head not quite 0·9 as long as broad at base, 155 (175) μ, as long as the pronotum, which is 1·8 times as broad as long, 150 (275) μ. The fore coxa project very slightly and the pterothorax, which is very short and strongly transverse, is no broader than the width across fore coxae (300 μ). Fore legs incrassate, fore femur as long as the head; fore tarsus apparently armed.

Antenna with dimensions of joints 3–8 as follows :—

♀. 40 (28) : 42 (29) : ? : ? : ? : ? μ.
♂. 40 (26·4) : 40 (27·5) : 40–42·5 (26) : 42·5 (23·5) : 30 (19) : 21·2 (12·5) μ.

Body broad, sharply widened with segments 2–5 almost subequal in width, thence gradually lessening in width, and 8–9 roundly narrowing to base of tube; tergites short and strongly transverse. Tube difficult to measure in the type, but apparently 0·56 as long as the head, the approximate length (and breadth at base and apex) being *c.* 87 (58 : 37·5). Terminal hairs about 0·7 as long as the tube, namely *c.* 62 μ.

♂. Length *c.* 0·8 mm. Head a little less broad as compared with the length, 145 (162) μ; pronotum enlarged, longer than the head, 188 (275), so that the mouth-cone only extends about two-thirds across the prosternum. Fore legs much enlarged, fore femur much longer than the head, *c.* 250 μ in length, and fore tarsus with a very large and broad tooth. Abdomen not so broad, *c.* 320 μ; tube measuring 90 (55 : 30) μ. Long bristles on 9 about 62 μ in length.

Measurements in μμ.	*F. acaciae*, sp. n. ♀.	*F. acaciae*, sp. n. ♂.	*F. inconsequens*, sp. n. ♀.
Length (and breadth) :			
a. Head	155 (175)	145 (162)	130 (175)
b. Pronotum	150 (275)	188 (275)	?125 (250)
c. Tube	87 (58 : 37·5)	90 (55 : 30)	98 (62 : 32·5)
d. Abdominal segment 4	390	*c.* 320	380
Length of terminal hairs	*c.* 62		*c.* 62
Length of setae :			
Fore-coxal	27	28	20
Pronotal postero-angular	? *c.* 30	*c.* 30	?
Abdominal lateral on segment 7	25 (*c.* 9)	30·5	32
" " " 8	35	35	*c.* 35
" " " 9	34	30	?

Australia, ? N.S.W., Termeil, 1 ♀ and 2 ♂♂ on Wattle (*Acacia* sp.), 27.ix.1899 (*W. W. Froggatt*).

Froggattothrips inconsequens, sp. n.

♀. Length about 0·8 mm.; breadth of pterothorax 0·276, and of abdomen 0·380 mm.

General form as in *F. acaciae*, colour dark blackish brown with fore tibia yellowish brown distally and all tarsi paler than tibiae. Antennae missing in the unique example. Close to *F. acaciae*, but, in addition to the dark coloration, separated from that species by the comparatively short head, which is scarcely 0·75 as long as broad; the longer tube as compared with the length of the head, the tube being 0·75 the length of head in *F. inconsequens* as compared with 0·56 the length in *F. acaciae*. The fore-coxal and pronotal setae would appear to be both shorter and less strongly dilated in this species.

Comparative measurements are given under the description of *F. acaciae*.

Australia, Termeil, 1 ♀ on Wattle (*Acacia* sp.) with *F. acaciae*, 27.ix.1899 (*W. W. Froggatt*).

SPIRAL AND OTHER ANOMALOUS FORMS OF SEGMENTATION

By E. A. Cockayne, D.M., F.R.C.P.

[Read June 5th, 1929.]

Plates XIII–XV.

Abnormalities of segmentation are well known in Annelids and occur both in free-living Oligochaetes and Polychaetes and in parasitic Cestodes, but spiral segmentation appears to be confined to the free-living forms. It is much commoner in some families or in some genera or even in one species of a genus than in others. Buchanan found segmental abnormalities so frequent in the Amphinomidae, a family of Polychaetes, that as many as one in three showed complete or incomplete half-somites or spiral somites or both.

In Arthropods they are much rarer. Spencer and Buchanan have each found an example of spiral arrangement in the somites of a female of the worm-like Arachnid, *Pentastomum teretiusculum*, Baird, which is an internal parasite of snakes. In the Myriapoda Brölemann has described two specimens of *Himantarium gabrielis*, L., with double spirals. In the first left-handed spirals started at the 134th and 135th somites and ended at the 137th and 138th, and in the second they started at the 69th and 72nd and ended at the 81st and 82nd. In both cases the sternites alone were affected and another segmental defect was present. In the first the 67th and in the second the 143rd and 144th sternites were un-united.

In Insecta various anomalies are met with, fused and absent somites, half-somites and spirals, and examples of partial or complete failure of union between the two halves of a tergite, and sometimes more than one of these is present in the same individual. In Diptera Townsend describes a *Clytia flava*, Twns., with the 2nd abdominal somite divided obliquely from the left anterior to the right posterior end, presumably on the dorsal surface only, and with the 3rd somite absent. Křiženecký records two larvae of the Coleopteron, *Tenebrio molitor*, L., each having the tergite of the 6th abdominal somite divided in the same way, but with the sternite normal, and Hein has found other specimens of the same beetle with this defect. True examples of spiral segmentation involving more than one somite appear to be very rare. In Coleoptera Megušar describes a larva of *Tenebrio molitor*, L., with the 6th and 7th abdominal somites forming a right-handed spiral, the oblique divisions occurring on the dorsal surface, and Arendsen Hein has figured several which he met with during his intensive study of this species. Bounoure describes and figures a larva of *Dytiscus marginalis*, L., with a right-handed spiral affecting the 2nd and 3rd thoracic somites and with incomplete separation of the 3rd thoracic from the 1st abdominal, the tergites being abnormal, but he states incorrectly that the spiral is formed by three somites. Scholz describes and figures an imago of *Stenocorus fasciatus*, F., with a left-handed spiral affecting the 1st and 2nd abdominal somites, the sternites being abnormal. In Lepidoptera Christeller describes and figures a *Deilephila euphorbiae*, L., in which the 4th, 5th, and 6th abdominal somites form a continuous spiral in both pupa and imago. In the figures, which show the ventral aspect, the

spiral is difficult to distinguish, but appears to be left-handed. In Hymenoptera Morice figures an imago of *Anthidium manicatum*, L., male, with six somites forming a right-handed spiral. The spiral begins on the dorsal surface of the 2nd abdominal somite; the left half of the 2nd tergite is fused with the right half of the 3rd, the left half of the 3rd with the right half of the 4th, the left half of the 4th with the right half of the 5th, the left half of the 5th with the right half of the 6th, and the left half of the 6th with the right half of the 7th; the sternites are all correctly fused, though the 7th is displaced to the right. The spiral in this *Anthidium* and in one of Hein's *Tenebrio* larvae, in which the same number of somites were involved, are the longest yet recorded in the Insecta. When the specimen was exhibited no one recognised the nature of the segmental error, though Chapman explained it afterwards in a foot-note, so that it is not unlikely that the *Gorytes quinquecinctus* shown by Morice in 1901 was another example of the same kind. For comparison with the other Hymenoptera I have given a diagrammatic drawing of the *Anthidium* (Plate XIV, fig. 1).

The discovery of two Lepidopterous larvae with spiral segmentation last year led me to look for other undescribed examples, and in the Teratological Collection of the British Museum I found four in Hymenopterous imagines in addition to the *Anthidium* and the larva of *Hipocrita jacobaeae*, which I mentioned in 1921 in my paper on "Structural Abnormalities in Lepidoptera." I also wrote to several Entomologists through whose hands much material passes, and the meagre results leave no doubt that in most orders the phenomenon is very rare. Mr. Donisthorpe has neither seen nor read of its occurrence in ants. Mr. G. T. Lyle said he had never seen it in a Braconid, but a very perfect example in an ichneumon had been submitted to him, though he could not remember from whom he had received it. Mr. C. J. Wainwright very kindly sent several segmental abnormalities in Diptera including the first spiral in this order.

Descriptions of these insects are given below.

Earias chlorana, L. A full-grown larva found on July 21st at Sandwich on *Salix viminalis*. (Plate XIII, fig. 1.)

The 3rd and 4th abdominal somites form a right-handed spiral and the 7th and 8th form a second, less perfect, running in the same direction. In a normal larva of this species there is a very narrow dark dorsal line running down the middle of a wide white dorsal stripe, which is bordered by a broad dark band on either side, the band being much darker above and below than in the centre. This dark band encroaches on the white stripe to a considerable extent in the middle of the 2nd and 8th abdominal somites. The pattern of the abnormal larva is slightly asymmetrical on the 1st and much more so on the 2nd abdominal somite. The pigment is very deficient and shows little of the usual distribution on the spiral somites. The 5th abdominal is asymmetrical but to a less degree; the 6th is almost normal, but in the 7th and 8th, which are completely separated beneath but incompletely above, the white dorsal stripe curves first to the right then to the left, and then back towards the mid-line. The arrangement of setae on all the abdominal somites except the 2nd, 6th, and 9th is very abnormal and some setae are missing. The ventral surface of the larva looks nearly normal, and the prolegs and spiracles are all present. A reference to the drawing will show the arrangement of pattern and setae better than a detailed description. The disturbance of pattern and the more important alteration of the setal arrangement in the somites not participating in the spirals is an interesting feature in this larva, which is unique amongst insects in having two independent spirals.

Pieris rapae, L. A full-grown larva found on cabbage on October 1st at Grimsby. (Plate XIII, fig. 2.)

The 2nd and 3rd abdominal somites form an imperfect right-handed spiral, the dorsal surface being the abnormal one. In the normal larva of this species there are five transverse bands on each abdominal somite, each band being covered with black dots of different sizes and separated from the next by a narrow line of plain cuticle; the first and fifth dotted bands are broader than the others and each shows an indication of subdivision into an anterior and posterior part. This arrangement can be seen also on the spiral somites, though less clearly. The yellow dorsal stripe has a projection to the left to meet the beginning of the spiral and a larger projection to the right to meet the end of it, as I have shown diagrammatically in my figure. The black dots on a normal somite are not quite symmetrical, and the symmetry is still less perfect on the abnormal ones. The defect is not visible on the ventral surface and the prolegs and spiracles are all present.

Hipocrita jacobaeae, L. Full-grown larva labelled "Champion. 1918." (Plate XIII, fig. 3.)

There is a right-handed spiral affecting the 4th and 5th abdominal somites. The right half of the 4th is completely separated from the left half on the dorsal surface, but the left half of the 5th is not separated from the 6th. As shown in the figure some of the setae are missing. The somites are normal on the ventral surface and each bears a pair of well-formed prolegs; the obliquity of the intersegmental lines is confined to the dorsal and lateral aspects.

In the descriptions of the Hymenoptera the first broad somite of the abdomen is called for convenience the first abdominal somite, though technically this is incorrect.

Polistes associa, Kohl. Male. F. D. Morice. 1902–11. (Plate XIV, fig. 2.)

The yellow markings on the 1st abdominal somite are asymmetrical. The 2nd and 3rd somites form a complete right-handed spiral, which begins on the dorsal surface. The sternites of the two somites concerned run with a very slight obliquity backwards and to the left. The rest of the insect is normal, though the last somite has been broken off.

For the identification I am indebted to Dr. J. Waterston.

Cerceris quinquefasciata, Panz. F. D. Morice, 1902–11. (Plate XIV, fig. 3.)

The 1st and 2nd abdominal somites form a right-handed spiral. The right half of the 1st tergite is completely separated from the left, but the left half of the 2nd is continuous with the tergite of the 3rd somite. The right half of the 1st tergite is much smaller than the left and the two yellow markings on it are correspondingly reduced in size; the yellow mark on the right half of the 3rd tergite is about the same size but of a different shape from that on the left half. The sternites are normal and the defect is only visible on the dorsal surface.

Osmia aurulenta, Panz. Female. F. D. Morice. 1902–11. (Plate XIV, fig. 4.)

The 3rd and 4th abdominal somites form a left-handed spiral. The left half of the 3rd tergite is incompletely separated from the right half, and the right half of the 4th is continuous with the 5th. The sternites are normal.

Odynerus callosus, Thoms. E. Saunders Coll. F. D. Morice dedit. (Plate XIV, fig. 5.)

The 2nd and 3rd abdominal somites form a right-handed spiral. The right half of the 2nd tergite is incompletely separated from the left half, but it cannot be seen whether the left half of the 3rd is separated from or continuous with the tergite of the 4th or not. The sternites are normal and show no obliquity.

Chrysotoxum elegans, Loew. Male. Brockenhurst. June 10th, 1908. (Plate XV, fig. 1.)

The tergite of the 2nd abdominal somite is much larger on the right than on the left side, and on the left side the division between the tergites of the 2nd and 3rd somites only reaches to the middle line; the right half of the tergite of the 3rd somite is very small and without the curved yellow marking, and the division between it and the tergite of the 2nd somite is not quite complete; the tergite of the 4th somite is larger on the right than on the left and the curved yellow marking is also larger on the right side; the sternites are normal. A left-handed spiral is formed beginning with the left half of the 2nd tergite, running below across the 2nd sternite, then up across the right half of the 2nd and the left half of the 3rd tergites, below across the 3rd sternite and ending with the right half of the 3rd tergite.

Ischyrosyrphus glaucius, L. Male. Boscastle. August 1st, 1891. (Plate XV, fig. 3.)

The right side of the tergite of the 2nd abdominal somite is longer but narrower than the left; the right side of the 3rd is shorter and narrower than the left and without the white marking and the usual hairs; the right side of the 4th tergite is slightly narrower than the left and its white marking is a little smaller in all dimensions.

Syrphus compositarum, Verr. Female. Gavarnie, S. France. July 30th, 1911. C. J. Wainwright. (Plate XV, fig. 4.)

The left side of the tergite of the 3rd abdominal somite is narrower than the right and is without the white marking; the whole tergite is devoid of hairs.

Eristalis arbustorum, L. Female. Fiesole, Centr. Italy. October 3rd, 1918. O. Querci. (Plate XV, fig. 5.)

The right side of the 3rd abdominal somite is very much reduced in size.

Myiobia tibialis, von Ros. Female. Selsley, Glos. (Plate XV, fig. 6.)

The tergite of the 2nd abdominal somite is much larger on the right than on the left side; only the left half of the tergite of the 3rd is present and this is incompletely cut off from the 2nd; the 4th somite is longer on the right than on the left side.

Macquartia dispar, Fall. Male. June 8th, 1901. C. J. Wainwright. (Plate XV, fig. 7.)

The left half of the tergite of the 2nd abdominal somite is larger than the right; the two halves of the tergite of the 3rd have failed to unite, the left half forming a small wedge-shaped area incompletely cut off from the tergite of the 4th and the right half forming a much larger wedge completely separated from both 2nd and 4th. There is considerable asymmetry of the macrochaetae, 2nd, 3rd, and 4th somites, some being misplaced and others missing. There is also some disturbance of pattern of which the black areas are indicated by dots and the grey left unshaded in the diagram.

Phryxe nemea, Mg. Female. St. Ives. 1895. (Plate XV, fig. 8.)

The 3rd abdominal somite is longer on the left than on the right side and the posterior margin of its tergite is notched at the centre. The left half of the 4th somite is very small and the arrangement and size and number of the macrochaetae is abnormal. The pattern is asymmetrical on the 3rd and 4th somites as shown in the diagram, in which the black areas are indicated by dots and the grey are left unshaded. For the sake of clearness only the chaetae of the 4th somite are drawn in the diagram.

The Mechanism of Spiral Formation and other Segmental Defects.

Our knowledge of the nature and origin of segmental defects has been derived in part from a study of Annelids and in part from insects. By finding in *Allolobophora foetida* specimens in which a split somite was present anterior to the openings of the vasa deferentia, which are almost invariably on the 15th somite in this species, Morgan showed that the two portions of a split somite were both true half-somites and that the formation was not due to the interpolation of an extra piece. His conclusion is based on the fact that in such a case, though the vasa deferentia of the two sides appear to open on different somites, each opening is really still on the 15th somite of its own side, if the split somite is counted as two. He thinks that, if, when the somites are being laid down to right and left of the mid-line, one or more of the blocks of mesodermal tissue from which they arise are smaller on one side than on the other, two blocks may fuse with a single block on the opposite side to form a split somite or one may fail to fuse at all with a block on the opposite side and form a half-somite. If for example the mesodermal blocks of somites 10 and 11 on the right are small, they may both fuse with that of 10 on the left, 12 on the right will then fuse with 11 on the left and so on, so that the opening of the vas deferens on the right side will be on the somite formed by the fusion of the 15th block on the right with the 14th on the left, and the opening of the vas on the left will be on the somite formed by the fusion of the 16th block on the right with the 15th on the left.

Hein's diagrams of segmental abnormalities in *Tenebrio* especially those of the pupae (Fig. 3, Nos. 1, 2, and 3) show that in insects too, a half-somite is not an extra one, and that in a split somite both parts are true half-somites.

After giving his explanations of half-somites in worms, Morgan proceeds to discuss the origin of spirals in the following words. "Furthermore, the same explanation that accounts for the split-segment is equally applicable to the spiral modification. If we imagine one of the mesodermic blocks of one side to be larger either above or below (but not both above and below), so that above (let us say) it opens into two body cavities of the opposite side, while below it opens into but one, then we have produced the conditions necessary to start the spiral. Each of the consecutive blocks on the same side as the larger block will open below into its own proper opposite block; but above (on account of the first displacement) into the one lying in reality behind it. The spirals when once started do not run on continuously, but end after passing around the body several times. The ending likewise finds its explanation in the inequality of the blocks of opposite sides."

Though the somites in Annelids and insects are not strictly comparable, the mechanism that gives rise to identical abnormalities of structure must itself be identical. In all the recorded examples of spiral segmentation in insects the abnormal division affects either the tergites or the sternites, but never both, and in the two Myriapods the sternites alone were abnormal.

This supports Morgan's view that the mass of cells that is about to form half a somite on the one side must be smaller dorsally than ventrally or vice versa, whereas on the opposite side the mass of cells must be equal in size both dorsally and ventrally before the formation of a spiral can begin. In insects more cases of a spiral starting in the tergites than in the sternites have been recorded, but the excess is probably apparent and not real, because abnormalities affecting the dorsal surface are in most insects much more conspicuous than those affecting the ventral surface.

Period at which Segmental Defects Originate.

Ehlers believed that in worms the abnormalities appeared after embryonic life and were all due to regeneration, but Morgan found both split and spiral somites in embryos and so proved that in some cases they were early developmental errors. He noticed, however, that they were less common in embryos than in adults, but thought that this could be explained as a rule by the great number of new somites formed by the growing worm, though he did not doubt that owing to the more irregular growth they were commoner in regenerated parts than in those formed by normal growth. In insects regeneration can play no part in their production, and they must arise during the development of the ovum. Segmentation of the primitive band in insects begins in the thoracic and anterior abdominal regions and proceeds gradually to the posterior, affecting ectoderm, mesoderm, and endoderm alike. It is already completed at the end of gastrulation, and any defects of segmentation must have arisen before this stage of development.

The setal and pigmentary disturbances associated with spiral and other defective forms of segmentation and even occurring on somites not participating in the spiral, as in the larva of *chlorana*, seem to show that an abnormality of the ectoderm, which persists through larval life, may originate at this early period. It is not improbable that some setal and pigmentary defects may be determined at this stage of development, even if no defect of segmentation has taken place.

Are Spirals and other Segmental Anomalies due to a Primary Error of Segmentation?

Chapman in discussing the origin of the spiral in the *Anthidium* said that the defect arose when the flanks of the embryo closed dorsally, and evidently thought that it resulted from some error in the closure. The spirals and other abnormalities formed during post-embryonic growth in worms, and probably in Myriapods also, are not secondary to any other structural defect, and may occur where no gross disturbance of cell growth has been caused by injury. The evidence is indirect but suggests that embryonic defects may be primary. Fortunately direct evidence to this effect is available. The occurrence in insects of spirals that begin on the ventral aspect instead of on the dorsal, proves conclusively that Chapman's explanation cannot be the only one. It is unlikely that the spirals that begin dorsally are caused in a different way from those that begin ventrally, and, since the ventral spirals are primary, it is probable that the dorsal spirals are also due to a primary error of segmentation.

In his note on the *Vespa germanica*, figured on Plate XV, Chapman said that an injury to the larva at a late stage of development might have prevented the union of the two halves of the tergite, but he considered it more likely that there had been a defect in the closing of the umbilical opening. If

the *Vespa* is regarded as an isolated case, the latter hypothesis appears probable, but taken in conjunction with other abnormalities, many of which have been recorded more recently, the likelihood that it is correct is much diminished.

In the first place the condition in the *Vespa* is exactly like that in one of Brölemann's Myriapods and closely resembles that in the other, but in both of them the failure of union occurred on the ventral surface and in somites added during post-embryonic growth. Either of these facts is sufficient to prove that in Myriapods defects of this kind can arise apart from defect or delay in closure of the umbilical opening.

In the second place it will be observed that in the *Vespa* the ends of the half-tergites cross the middle line and overlap on the dorsum. Had they crossed still further we should have had a somite divided obliquely as in Townsend's *Clytia flava* and in some of Hein's *Tenebrio* larvae, or on the contrary, had they not reached the mid-line, we should have had the condition seen in the *Macquartia* described above or in Bassi's larva of *Bombyx mori*. Various abnormalities, some closely resembling these, have been found by Hein in one part of a *Tenebrio* larva and a spiral, or a split, or half-somite, in another part of the same larva. In view of the strong evidence that these last conditions always appear in insects in embryonic life, and sometimes in Annelids owing to a primary error of segmentation, one may assume that the other defects found with them arise at the same period and in a similar way. Records of defects of the sternites, other than spirals, in insects would be welcome as they would strengthen the evidence in favour of this conclusion.

The Cause of Errors of Segmentation.

The nature of the mechanism and the period of origin of the segmental defects of insects and the fact that they are primary errors of segmentation are thus established, and the cause alone remains for discussion. Hein has shown that in *Tenebrio* the irregular division of the primitive band is not due to an inborn error. He found 62 abnormalities of segmentation amongst 38,800 larvae, and abnormal segmentation was no commoner in their offspring even in the F2 generation, than amongst larvae picked at random. In *Drosophila*, on the other hand, a segmental defect behaving as a sex-linked dominant was discovered, but the abnormality only appeared if the culture was reared in a wet bottle. Even in this case an external cause was necessary in order to make apparent the inherent instability of segmentation. It seems probable that most of the abnormalities of this kind taken at large are not inherited and must be due to some external cause acting on the ovum at the very early period when the somites are being formed.

Cappe de Baillon in his study of double monsters in *Carausius morosus* found various segmental anomalies, absence of one or more whole or half-somites, fusion of somites, and spirals, fairly frequently and attributes them to the pressure caused by the unusually large embryo confined in the unyielding egg-shell. This explanation, however, cannot be applied to the examples in insects cited in this paper, or to those in Annelids and Myriapods, and in their case we have at present no knowledge of the cause. Whatever it is, there is little doubt that either the regular process of segmentation is much more readily disturbed in some species than in others, or owing to their embryonic environment the causes conducive to it are more able to act on some than on others.

Once the spiral formation has been established it persists throughout life

and in insects is perpetuated through the different metamorphoses. It is one of the most interesting phenomena met with in insect teratology altering, as it does, so fundamental a matter as the orderly arrangement of the somites.

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Explanation of Plates XIII–XV.

Plate XIII.

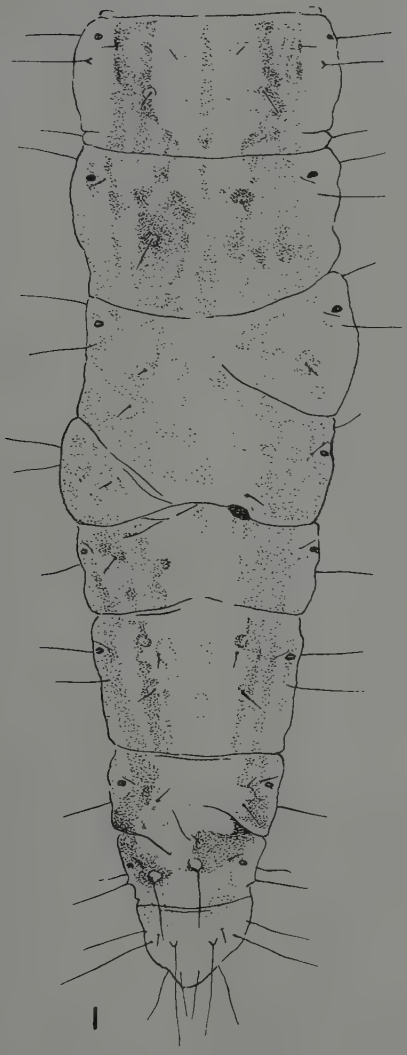
Fig. 1. Larva of *Formia chlorana*, L.
2. Larva of *Pieris napi*, L.
3. Larva of *Hyponomeuta padellus*, L.

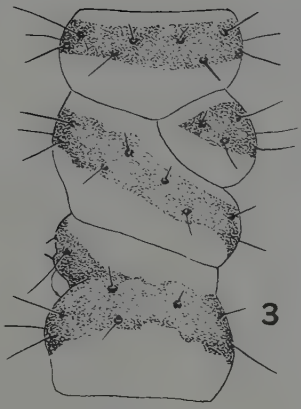
Plate XIV.

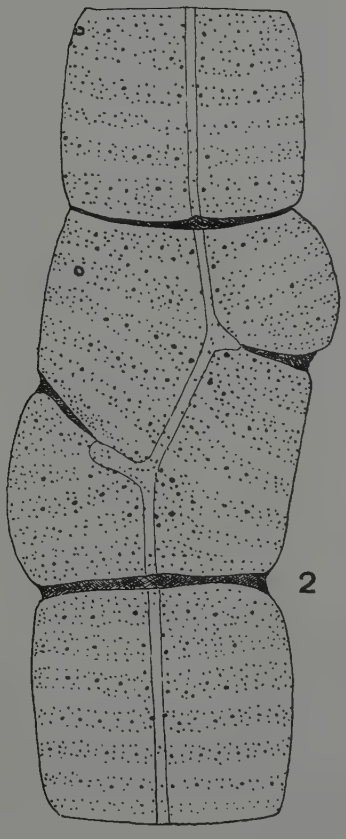
Fig. 1. *Amphidasys betularius*, L.
2. *Phigalia pedaria*, Fab.
3. *Cheimatobia brumata*, Linn.
4. *Ennomos quercinaria*, Hufn.
5. *Selenia tetralunaria*, Hufn.

Plate XV

Fig. 1. *Hyphantria cunea*, Drury.
2. *Lymantria monacha*, Fabr.
3. *Leucoma salicis*, L.
4. *Stilpnotia salicis*, Fabr.
5. *Euproctis chrysorrhoea*, L.
6. *Porthesia similis*, Fuess.
7. *Malacosoma neustria*, Fabr.
8. *Dasychira pudibunda*, Fabr.







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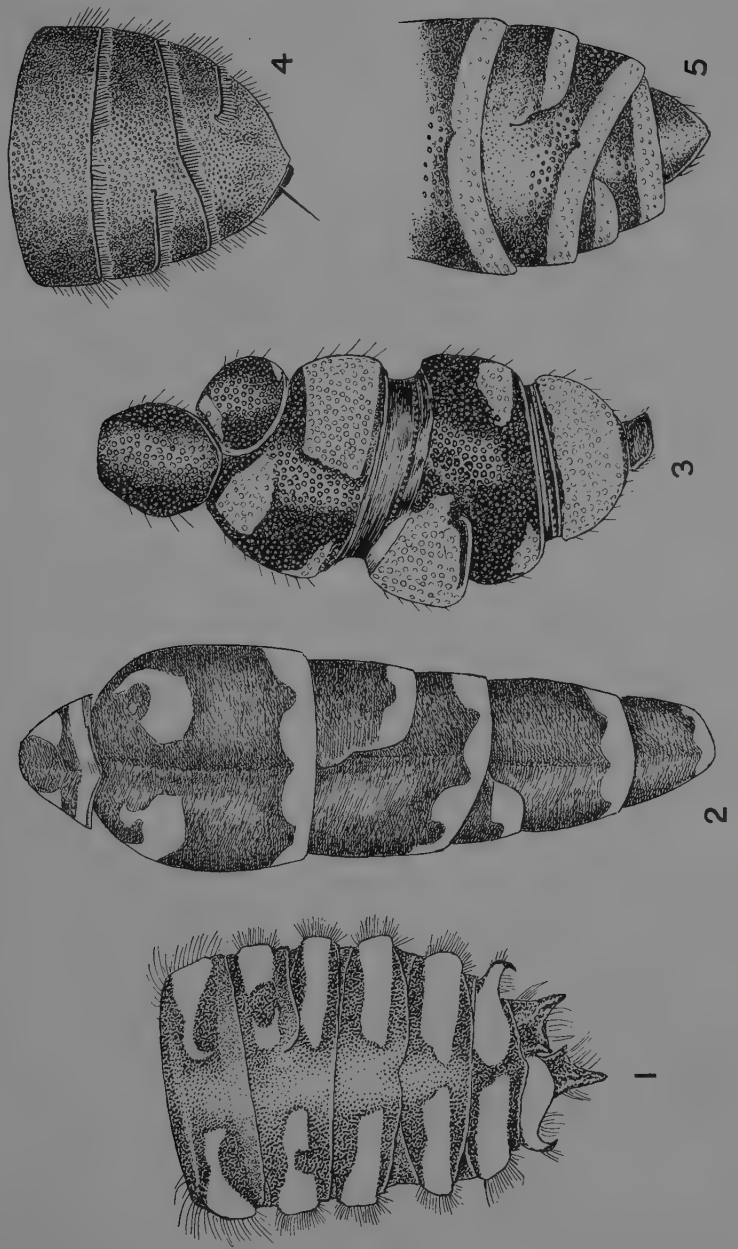
SPIRAL AND OTHER ANOMALOUS FORMS OF SEGMENTATION.



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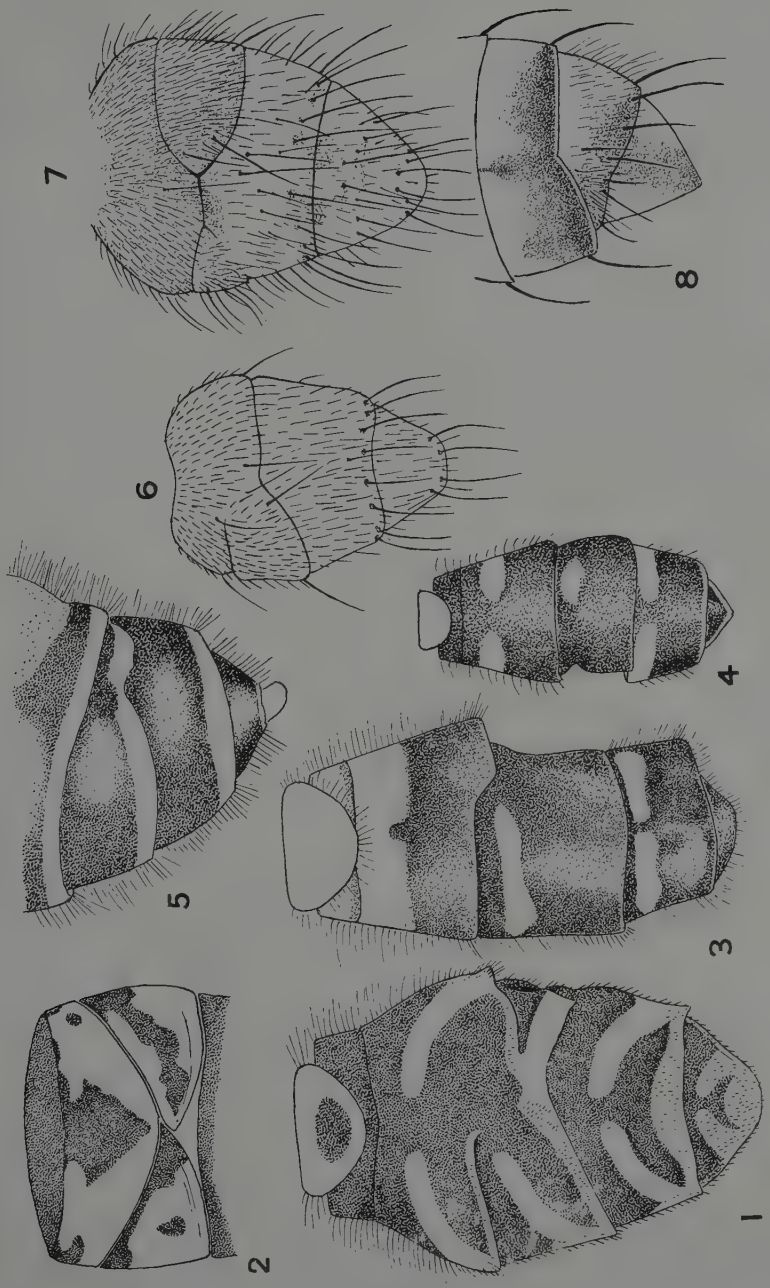

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SPIRAL AND OTHER ANOMALOUS FORMS OF SEGMENTATION.

NOTES ON THE COLEOPTEROUS GENUS *AMPAGIA* (CURCULIONIDAE), WITH DESCRIPTIONS OF NEW SPECIES

By Arthur M. Lea.

[Read May 1st, 1929.]

Plate XVI.

The genus *Ampagia* has its headquarters in Australia, but occurs on several islands in the Pacific, and one species can now be recorded from the Malay Peninsula, extending the range into Asia. No less than six species occur on Lord Howe Island, but one of these is represented before me only by a headless and badly-abraded specimen, so it has been left unnamed. Probably many other species remain to be discovered in Australasia and Malaysia.

The species are all more or less strongly convex and elliptic, and are capable of folding the rostrum, antennae and legs so closely together that they resemble seeds; in this condition they remain motionless for some time and so may easily escape observation by insectivorous birds, lizards, etc. Some of the species occur under bark, and others on foliage of shrubs; most of them are coastal, but others occur at elevations up to 2000 feet.

The genus is remarkable for the abdomen and legs (especially the hind femora) of all its species; the former has the basal segment large, with a large median plate, isolated from the sides by a curved or oblique impressed line from each coxa to the apex; the apex of the plate is usually pointed in the middle; viewed from the sides the first segment usually appears to overhang the second, and, the latter being often more or less vertical, the first segment is on a different plane from the others.

The femora are longitudinally grooved to receive the tibiae, and the hind ones are wide, more or less angular, and their hind ends when at rest meet on the abdomen so as entirely to conceal the median plate. Each tibia is so applied to the femur, that its base slightly curves over the base of the latter, and (from some directions) a small free space may be seen between them. Each of the middle tibiae has an outer projection at the base. The intercoxal process of the mesosternum is strongly elevated above the adjacent parts, and is cavernous in front (much as in *Idotasia*). The eyes are large and have coarse facets.

Most of the species are densely clothed with scales, and have two white spots on the elytra, and the spots may be almost or quite conjoined to form a V; the scales, however, are easily abraded. In addition to scales many of the species have stout, erect or suberect setae.

Several of the species have ample wings, capable of being used for flight; on others the wings are rudimentary, being reduced to thin strips, quite useless for flight. To see them it is necessary to force the elytra apart; but when only one or two specimens were before me and I attempted to force the elytra apart, the resistance was sometimes so great that I had to desist for fear of breaking the specimen. On winged species the clothing usually consists of scales only; where the wings are rudimentary, of both scales and setae.

The genus was first named by Pascoe from the Western Australian *A. erinacea*, and placed near *Sympiezoscelus*, " without being closely allied to it."

It is certainly, however, close to *Idotasia*, to which genus, in fact, two of its species were referred by Olliff. Pascoe also described a New Zealand species, but referred it to a new genus *Acallopais*, and Broun subsequently referred a second New Zealand species, *A. sculpturatus*, to the same genus. Chevrolat proposed the genus *Coptomerus* to receive a new species from Queensland; and Erichson referred a Tasmanian species to *Cryptorhynchus*.

Pascoe also proposed the genus *Amydala* for a species (*A. abdominalis*), which has abdomen and legs similar to those of all the known species of *Ampagia*, but differs considerably in the antennae, and should perhaps be maintained as distinct. To this genus I referred a new species, *A. tarsalis*, and transferred *Coptomerus nigrinasus* to it, but I think now that the two latter species really belong to *Ampagia*.

The genus therefore, including some new ones, consists of the following species :—

Australia.

ALATA, Lea, Proc. Linn. Soc. N.S. Wales, 1912, p. 605. Queensland, N.S. Wales, Victoria.
ERINACEA, Pasc., Trans. Ent. Soc. Lond., 1870, p. 209, pl. 5, fig. 1. W. Australia.
HIEROGLYPHICA, n. sp. Queensland.
NIGRINASUS, Chev. (*Coptomerus*), Ann. Soc. Ent. Fr., (6), i, 1881, p. lxix. Queensland.
TARSALIS, Lea (*Amydala*), Trans. Roy. Soc. S. Aust., 1913, p. 443. Queensland.
V-ALBUM, Lea, n. sp. Queensland.

Tasmania.

COGNATA, Lea, Proc. Linn. Soc., N.S. Wales, 1912, p. 607.
FEMORALIS, Er. (*Cryptorhynchus*), Arch. Naturg., 1842, i, p. 204. Tasmania and King Island.

Lord Howe Island.

LEUCOMELA, n. sp.
MONTIVAGA, Oll. (*Idotasia*), Mem. Aust. Mus., 1899, p. 93.
OBSCURA, n. sp.
SQUAMIBUNDA, n. sp.
SQUAMIGERA, Oll. (*Idotasia*), *l.c.*, p. 93.

New Zealand.

RUDIS, Pasc. (*Acallopais*), Ann. Mag. Nat. Hist., (iv), xix, Feb. 1877, p. 147.
SCULPTURATA, Broun (*Acallopais*), Man. N.Z. Col., 1880, p. 495.

Fiji.

BASICOLLIS, n. sp.
RUDESQUAMEA, Fairm., Ann. Soc. Ent. Fr., (6), i, 1881, p. 312.
VITIENSIS, n. sp.

New Caledonia.

CRIBRICOLLIS, n. sp.
GRANULIFERA, n. sp.
SETICURVA, n. sp.

Asia.

SORDIDA, n. sp. Malay Peninsula.

Ampagia erinacea, Pasc. (Pl. XVI, fig. 1.)

The outline of an antenna of this species is given for comparative purposes.

Ampagia nigrinasus, Chev. (Pl. XVI, figs. 2, 6.)

As the abdomen and legs of this species are in close agreement with those of *Ampagia*, and its antennae are nearer to those of that genus than to those of *Amydala*, it seems desirable to refer it to the former genus.

Ampagia tarsalis, Lea. (Pl. XVI, fig. 3.)

This species also has antennae more in accordance with those of *Ampagia* than of *Amydala*.

Ampagia montivaga, Oll. (Pl. XVI, figs. 7, 10–12.)

This species usually has the upper surface black, but on many specimens each elytron has a broad reddish vitta continuous from the base almost to the apex; on some the vitta is very distinct, but it varies till it may be perceptible only as an obscure dilution. The type and specimens previously noted by myself * were almost glabrous, but this was due to abrasion; on specimens in perfect condition there are fairly numerous, stout, white, depressed scales on the upper surface, mixed with smaller and darker ones; several specimens have five pale spots on the pronotum, two on each side and one in the middle. On the elytra the pale scales are in three series, a fairly distinct basal one, a diffused postmedian one, and one in the middle forming a V; but the scales are so easily abraded that a distinct pattern is seldom traceable. On the basal segment of the abdomen there is a deep oblique line, from each coxa to the middle of the apex, marking off a triangular plate, which at the apex is rather acute, and slightly overhangs the second segment; on the male the plate is longitudinally concave, on the female it is slightly convex. Each side triangle of the metasternum has shallow inconspicuous punctures. Wings of the ordinary weevil type are present and capable of being used for flight. The size ranges 3·0–4·5 mm. The species is abundant on Lord Howe Island, including the summit of Mount Gower.

Ampagia squamigera, Oll.

The type of this species was described as having a median line and two spots of pale (yellowish-grey) scales on the pronotum, and each elytron with a spot of similar scales in the middle. The pale scales, however, vary considerably in distribution; the median line on the pronotum is often broken up into spots, may be entirely absent, or may be extended to join the lateral spots; on each elytron there is usually a fairly large spot, but there may be numerous smaller ones also, frequently consisting of but one or two scales. The abdominal plate is semicircular, except that the middle of its apex is sometimes pointed. The general outlines are somewhat as in *A. montivaga*, but the species is slightly wider in proportion, and the white scales appear never to form a definite pattern, the size is also consistently less (2·5–3·0 mm.), and the wings are reduced to thin strips without venation, and are useless for flight. Numerous specimens were obtained on *Kentia* palms on Lord Howe Island.

Ampagia rudis, Pasc. (Pl. XVI, fig. 8.)

The abdomen, mesosternal receptacle, rostrum, eyes, antennae, and legs of this New Zealand species are quite typical of *Ampagia*; the abdominal plate is bounded by a semicircular line, but this is somewhat obscured by clothing.

* Lea, *Proc. Linn. Soc. N.S. Wales*, 1912, p. 604.

Ampagia sculpturata, Broun.

The type of this species is in the British Museum; it was associated without expressed doubt, by Broun, with the preceding species, but the abdomen and hind legs were not mentioned. I have not seen a specimen of it.*

Ampagia rudesquamea, Fairm.

Apparently differs from the two Fijian species before me in being somewhat larger and with the suture more convex at base and posteriorly "*subproductis.*"

Ampagia (Amydala) abdominalis, Pasc. (Pl. XVI, figs. 4, 5.)

The abdomen and legs of this species are much as in all the species here referred to *Ampagia*, but as the antennal club is very different it may be desirable to regard *Amydala*, which was originally proposed for its reception, as a distinct but allied genus.

Ampagia squamibunda, n. sp. (Pl. XVI, figs. 13–18.)

♂. Reddish-brown, a large infuscated spot (sometimes blackish) on the side of each elytron near base. Densely and almost uniformly clothed with whitish-grey scales.

Rostrum straight; with dense concealed punctures on basal half; densely punctate and shagreened in front of antennae. Club short and compact. Prothorax subtriangular, with dense, normally concealed punctures. Scutellum minute. Elytra with outlines continuous with those of prothorax; with regular rows of fairly large, almost concealed punctures; the interstices with minute concealed ones. First segment of abdomen pointed at apex, with a semicircular impressed line extending from each coxa to apex, the surface of the enclosed space sparsely clothed, shagreened and punctate. Side triangles of metasternum with numerous partially concealed punctures. Femora grooved for reception of tibiae and tarsi, the hind ones dilated, when at rest meeting in middle so as to conceal the abdominal plate. Length, 3 mm.

♀. Differs in having the rostrum thinner, not shagreened, and with distinct punctures from base to apex, tip of first segment of abdomen less pointed and legs somewhat smaller.

Lord Howe Island (*A. M. Lea*).

An elliptical, strongly convex species, with continuous outlines as viewed both from above and from the sides. There are strap-like rudiments of wings, much as those of *A. squamigera*, from which the species differs in its paler body and very different clothing, the scales being almost entirely pale, except that on some examples there are small spots of brownish scales, notably on the latero-basal infuscations of the elytra; on one specimen most of the scales on the prothorax and elytra are dark, and there are some brownish scales even on its femora. The punctures on the apical sides of the prothorax are dense and confluent, appearing much like oblique striae alternating with fine ridges, but normally this is not evident owing to the clothing. The lateral interstice on each elytron is quite as densely clothed as the adjacent ones. Seventeen specimens were obtained on the island. *A. montivaga* is a consistently larger, darker, and more sparsely clothed species.

* A careful comparison of the types of this and the preceding species, now in the British Museum, shows them to be closely related.—Gilbert J. Arrow.

Ampagia leucomela, n. sp. (Pl. XVI, figs. 9, 19.)

Black, rostrum blackish, antennae and tarsi more or less reddish. Densely clothed with black and whitish scales, closely applied to the derm.

Rostrum rather short, basal third with dense scales concealing the punctures, apical two-thirds shining and with small punctures along middle, with larger and crowded ones on sides. Scape scarcely half the length of funicle, club compact. Prothorax subtriangular, punctures normally concealed. Scutellum small but distinct. Elytra with outlines continuous with those of prothorax; with narrow, partially concealed striae. Basal segment of abdomen with an impressed line from each coxa to middle of apex, where the enclosed plate is obscurely pointed, the plate itself with dense scales, but these somewhat more pointed than on the adjacent parts. Metasternal triangles with rather large punctures. Femora strongly grooved, the hind ones larger than the others. Length, 4·5 mm.

Lord Howe Island (*J. B. Waterhouse*); unique.

A comparatively large species, at once distinguished from the preceding one, and from *A. squamigera* by the possession of ample wings. *A. montivaga*, which has also flight wings, is very differently clothed, and its abdominal plate is practically glabrous. The scape and basal joint of funicle are paler than the rest of the antennae. On the upper surface sooty-black scales are in the majority, the whitish ones being scattered singly and condensed into three spots on the pronotum (two in front and one in the middle) and two on each elytron, and rather dense about the apex; on the head and under parts most of the scales are whitish. There are punctures in the elytral striae, but they are usually concealed. The basal third of the rostrum is clothed, but as the part in front of it is shining in the middle the type is probably a female.

Ampagia obscura, n. sp. (Pl. XVI, fig. 21.)

Blackish-brown, some parts obscurely diluted with red; antennae, tibiae and tarsi reddish. Moderately clothed with small, inconspicuous, sooty-brown scales.

Rostrum not very long, feebly ridged along middle, with coarse punctures about base, with smaller ones and shagreened elsewhere. Club compact. Prothorax triangular; with dense, sharply defined punctures, rather coarser on sides than in middle. Scutellum very minute. Elytra with outlines continuous with those of prothorax; with narrow striae containing punctures, which become rather large on sides. Abdominal plate and femora much as on *A. squamibunda*. Metasternal triangles with large and deep punctures. Length, 2·75 mm.

Lord Howe Island (*A. M. Lea*).

Structurally close to *A. squamibunda* and *A. squamigera*, and with similar strap-like wings useless for flight, but with very different clothing; there are also some sloping setae between the eyes, such as are not present on those species. The head and prothorax from above appear almost to form an equilateral triangle. A single specimen was beaten from a *Kentia* palm.

Ampagia hieroglyphica, n. sp.

♀. Dark reddish-brown, rostrum, antennae and legs paler. Densely clothed with pale stramineous-brown scales, with sooty-brown or black markings; elytra with rows of white setae, not rising above general level.

Rostrum shining and with small punctures, a few on each side of base. Antennae inserted about one-third from base of rostrum, scape very little longer than club, which is rather short and compact. Prothorax slightly shorter than its basal width, sides evenly decreasing in width from base to apex; with dense, concealed punctures. Scutellum small but fairly distinct. Elytra with outlines continuous with those of prothorax; with narrow striae containing small punctures, both normally concealed. Triangles of metasternum with numerous partially concealed punctures. Abdomen with a curved line from each coxa to apex, which is pointed in middle and slightly overhangs second segment. Legs as in other species of genus. Length, 4 mm.

Queensland: Bunya Mountains in December (*H. Hacker*). Type in Queensland Museum.

There are two small dark spots of scales on the middle of the pronotum, and four larger subtriangular ones at the base. On the elytra the dark scales form an irregular patch about the scutellum, irregularly connected with a patch on each side about the middle, each of which is connected with an irregular post-median patch, wider at the suture than elsewhere; there is also a small patch traversing the suture halfway down the apical slope, and appearing as two subisolated spots. Ample flight wings are present. The species is without erect or subcrect setae, and so approaches *A. nigrinasus* and *A. tarsalis*, but the pronotum is without the conspicuous subapical spot of each of those species.

Ampagia v-album, n. sp.

Blackish, antennae and tarsi obscurely reddish. Densely clothed with dingy brown scales, variegated with whitish and blackish ones, and with numerous stout erect or suberect setae, mostly black.

Rostrum rather short and wide, basal third with punctures concealed by scales, rather coarse on sides and fine along middle. Club short and compact. Prothorax about as long as basal width, sides rather strongly diminishing in width from base to apex; punctures dense and normally concealed. Scutellum small but distinct. Elytra with outlines continuous with those of prothorax; with narrow striae indicated through clothing, but their punctures normally concealed. Basal segment of abdomen with an oblique line from each coxa, the two meeting at an obtuse point in middle of apex. Triangles of metasternum with rather large punctures, each containing a scale. Legs as in other species of genus. Length, 3·6 mm.

Queensland: Kuranda in December (*H. M. Hale* and *N. B. Tindale*).

The type has a rather thin white V on the elytra, touching the suture before the middle and directed towards but not quite reaching the shoulders; there are some obscure dark patches on the sides, and a conspicuous black patch composed of erect setae, on the third interstice before the V, and another on the second and third interstices beyond it. The clothing on the under surface and legs is almost entirely pale. There are ample flight wings. The species is allied to *A. alata*, but is slightly larger, and the white V narrow; the alternate interstices of the elytra are not conspicuously different from the others, and the setae are longer and more erect.

Ampagia basicollis, n. sp. (Pl. XVI, fig. 22.)

♂. Black, some parts obscurely diluted with red; antennae and tarsi reddish. Densely clothed with depressed more or less variegated scales, and with numerous stout erect setae.

Rostrum rather wide, basal half densely clothed, apical half with rather crowded but sharply defined punctures. Club short and compact. Prothorax almost as long as the basal width, which is almost twice as much as that of apex; with dense, concealed punctures. Scutellum minute. Elytra with outlines subcontinuous with those of prothorax; with narrow striae near suture and rows of large punctures towards sides, the outer interstice on each elytron polished. Plate of basal segment of abdomen sharply defined by a semicircular impressed line, depressed in middle, sparsely clothed and with small but fairly distinct punctures; second and fifth segments with denser clothing than the others. Metasternal triangles with numerous concealed punctures. Legs as in other species of genus. Length, 2·5 mm.

♀. Differs in having the rostrum thinner, less of the base clothed, the punctures smaller and less crowded, and the abdominal plate convex.

Fiji: Viti Levu (*A. M. Lea*).

On the type (and several specimens closely resemble it) the scales are mostly of a pale stramineous-brown or fawn-coloured; on each elytron there is a distinct white spot, placed obliquely on the second and third interstices, slightly beyond the basal third, and there are many smaller white spots scattered about, often consisting of a single scale; on the pronotum there is a large medio-basal patch (connected with the apex by a narrow median line) of fawn-coloured scales, mixed with small whitish spots. On several specimens the large medio-basal patch is almost uniformly pale and somewhat triangular in shape. The scales, however, vary considerably, and on some specimens are of an almost uniform muddy-grey, but the pale spot on each elytron is seldom completely absent. Where the setae arise amongst white scales they are themselves white, elsewhere they are black or blackish; they are, however, always entirely absent from the pale medio-basal patch of the pronotum. After abrasion the elytra are seen to have narrow, sharply defined striae, containing small punctures near the suture, but these alter so that on the sides the striae are feeble and the punctures large and deep. Wings are reduced to thin strips, useless for flight. In general appearance the species is strikingly close to the Queensland *A. hystricosa*, but it differs in the setae being slightly stouter and in the outer margin of each elytron being polished from the base to near the apex; when viewed from the sides the prothorax is also seen to be flattened at the base and the elytra elevated above it, so that their outlines do not form a continuous curve, as in that species and in the following one.

Ampagia vitiensis, n. sp. (Pl. XVI, fig. 23.)

♂. Blackish-brown, some parts obscurely diluted with red, antennae and tarsi reddish. Densely clothed with more or less variegated scales, and with short, stiff, sloping setae.

Rostrum stout, basal half densely squamose; elsewhere opaque and with coarse crowded punctures, but shining and ridged along middle. Club short. Prothorax almost as long as the basal width, sides evenly decreasing in width to apex; punctures dense but normally concealed. Scutellum minute. Elytra with outlines continuous with those of prothorax; with narrow striae containing small punctures near suture, rapidly altering till on the sides the striae are feeble and the punctures large and deep, but both normally concealed or obscured by the clothing. Basal segment of abdomen with a curved line from each coxa to middle of apex, the enclosed plate slightly concave, sparsely clothed, shagreened and with punctures of moderate size. Metasternal triangles with rather large, squamiferous punctures. Legs much as in others of genus. Length, 2·5–2·7 mm.

♀. Differs in having the rostrum slightly longer, less of the base squamose, elsewhere shining and with smaller punctures, and abdominal plate gently convex.

Fiji: Viti Levu, Vanua Levu, Ovalau, Moturiki, Mokondronga, Taveuni and Wakaya (*A. M. Lea*).

The scales vary considerably, on many of the specimens they are largely fawn-coloured, or stramineous-brown, with black markings and sometimes two white spots on the elytra, but the black markings vary in disposition and extent, and the white ones may disappear; on some specimens the scales are almost uniformly greyish, and they are easily abraded. On the type male and female about half of the scales are pale brown, the prothorax has four blackish spots at the base and two in the middle, the outer basal spot on each side appears rather small from above, but from the side appears as a large triangle, on some specimens extending almost to the apex; on each elytron there is an irregular white spot about the basal third (this spot varies considerably in size and density), behind it there is a black triangle dilated to the side (or, on some specimens, it may appear as an oblique interrupted fascia, extending from the suture to the side near the shoulder); there are some small blackish spots scattered about, and, many of the suberect setae being white, the surface generally has a speckled appearance. On the rostrum, under surface and legs, the scales are mostly whitish. The wings are thin strips, useless for flight, but there are remnants of three longitudinal veins in them. The species is, on the average, slightly larger than the preceding one, and has the setae shorter and less erect, although fairly distinct from the sides; they are quite as distinct on the middle of the base of the prothorax as elsewhere. The prothorax and elytra, as viewed from the sides, have their outlines continuous.

Ampagia cribricollis, n. sp.

♂. Blackish-brown, some parts obscurely paler, antennae and tarsi reddish. Densely clothed with variegated scales, and stout, erect setae.

Rostrum stout, basal half densely squamose and setose, elsewhere with rather coarse punctures. Club rather stout. Prothorax distinctly shorter than the basal width, which is about one-third more than that of apex; with crowded, concealed punctures. Elytra with outlines continuous with those of prothorax; punctate-striate near suture, with rows of large punctures towards and on sides; marginal interstice polished. Basal segment of abdomen with an oblique line from each coxa to apex, the enclosed plate pointed, slightly concave, sparsely clothed, and with numerous distinct punctures. Metasternal triangles with rather large concealed punctures. Legs as on others of genus. Length 2·0–2·7 mm.

♀. Differs in having the rostrum somewhat thinner, less of the base clothed, the exposed punctures smaller, and the abdominal plate slightly convex.

New Caledonia: Noumea (*A. M. Lea*).

On the type the scales are mostly of a rather dingy brown, becoming somewhat paler on the under parts; on the prothorax and elytra there are several obscure dark spots, and on each elytron there is a feeble spot about the basal third. On most of the specimens, however, the scales are but slightly variegated, and from several of them the whitish spots are absent. The setae are black and white, irregularly distributed, but the black ones are in the majority. The sculpture of the upper surface (except the elytral margins) is normally almost or quite concealed by the clothing. Remnants of wings, useless for flight, are

present, and have rudimentary venation on the basal half. The scutellum is minute and scarcely traceable. It is a strongly convex, narrowly elliptical species, close to the Fijian *A. basicollis*, but when viewed from the sides the prothorax and elytra appear to have an even outline, as in the Queensland *A. hystricosa*, from which it differs in being more strongly convex and in having the marginal interstice of each elytron polished. Eleven specimens were obtained.

Ampagia seticurva, n. sp.

♀. Blackish-brown, some parts obscurely paler, antennae and tarsi reddish. Densely clothed with variegated scales, and with stout, curved setae.

Rostrum stout, densely clothed near base; elsewhere with numerous rather small, elongated punctures. Prothorax about as long as the basal width, which is about twice as much as that of apex; with dense, normally concealed, punctures. Scutellum distinct. Elytra with outlines subcontinuous with those of prothorax. Basal segment of abdomen with a curved line from each coxa to middle of apex, the enclosed plate large, with rather large punctures, and with scales much as on the second and fifth segments, although not quite as dense. Legs much as in others of genus. Length, 3·25 mm.

New Caledonia: Noumea (*A. M. Lea*); unique.

The scales are mostly of a stramineous-brown colour, becoming almost uniformly pale on the under surface, but variegated on the femora. On each elytron there is a conspicuous white spot about the basal third, preceded by a black spot, and followed by several irregular black ones; there is also a rather large irregular black spot on the side. The setae are shorter than usual and are mostly curved, they are well defined only from sides, and are mostly black; on the pronotum many are condensed to appear as small spots; the white setae are sparse and scattered singly, except that they are fairly numerous on the white spots. The type, being unique and with scales in perfect preservation, has not been abraded, but the elytra appear to be punctate-striate near the suture, and with rows of large punctures near the sides; their marginal interstices are partly glabrous. The elytra were not forced apart to make certain of the condition of the wings. It is a comparatively wide species, with the scutellum larger than usual, and the elytra with sharply defined markings; in the preceding species the setae are much longer, and not at all curved.

Ampagia granulifera, n. sp.

Black, antennae and tarsi reddish. Irregularly clothed with large, soft, somewhat variegated scales, and with numerous erect setae, many of which are clavate.

Rostrum short, clothed only near base; elsewhere with crowded punctures, except along middle, which is shining and slightly ridged. Club short. Prothorax not quite as long as the basal width, which is twice as much as that of apex; with dense punctures, partially concealed by scales. Scutellum minute. Elytra with outlines continuous with those of prothorax, both from above and from the sides; with small punctures in feeble striae near suture, with rows of large ones on sides, becoming smaller and set in striae posteriorly. Abdomen with a curved line from each coxa to middle of apex of basal segment, the enclosed plate semicircular, with rather dense, sharply defined punctures, and with thin scales or setae. Metasternum with rather coarse punctures on side triangles; with a distinct granule on each side between middle coxa and elytron. Legs much as in others of genus. Length, 3·5–4·0 mm.

New Caledonia: Noumea (*A. M. Lea*).

The scales on the pronotum are unusually large, and are mostly of a sooty-brown colour, varying to a dingy whitish-grey; on the elytra the individual scales are somewhat smaller, but vary similarly in colour, being dense on most parts, but sparse on the sides; on the hind femora the scales are whitish, with a large dark basal patch. The species is slightly larger than the preceding one, and has numerous long, erect or suberect, clavate setae; the scutellum also is very small and round, instead of being truncated in front as in *A. seticurva*. The granule on each side of the metasternum is a distinctive feature. The elytra are apparently soldered together, so probably the wings are rudimentary. Two specimens, apparently females, were obtained.

Ampagia sordida, n. sp. (Pl. XVI, fig. 20.)

♂. Black, antennae and tarsi reddish. Densely clothed with somewhat variegated scales, and with numerous erect setae, mostly blackish.

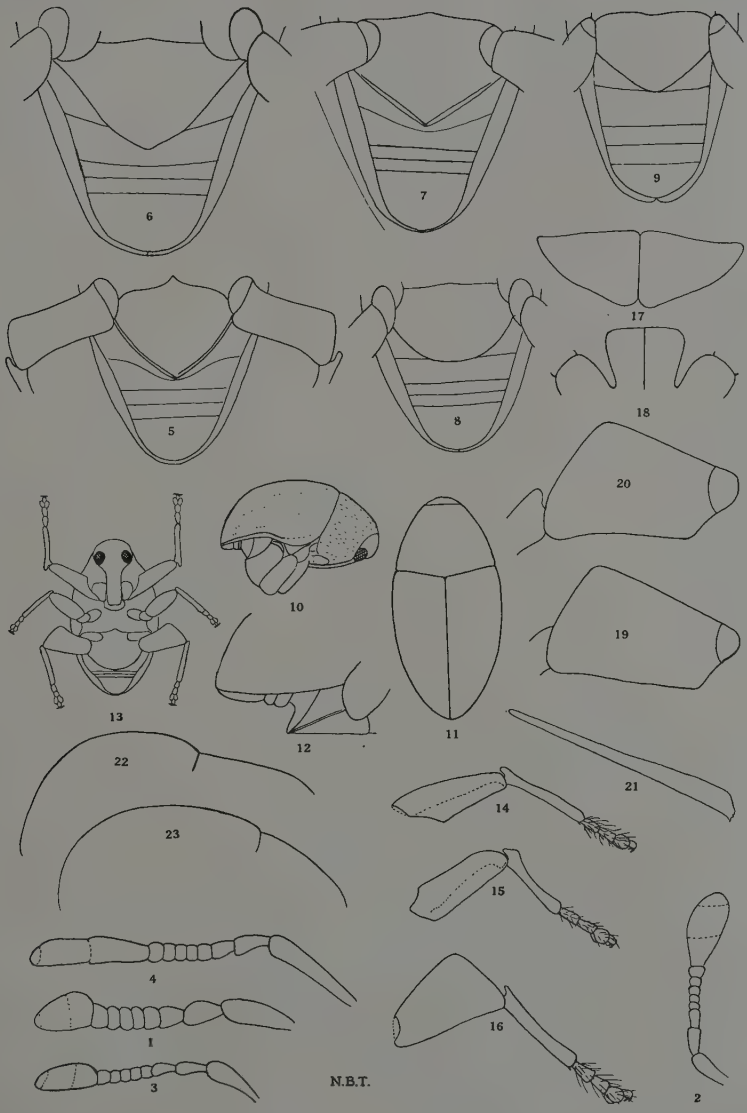
Rostrum rather wide, basal half densely squamose, apical half opaque and with crowded punctures. Club short. Prothorax almost as long as the basal width, which is almost twice that of apex; with crowded, normally concealed, punctures. Scutellum inconspicuous. Elytra with outlines continuous with those of prothorax; punctures and striae normally almost or quite concealed. Basal segment of abdomen with a curved line from each coxa to middle of apex; the enclosed plate slightly concave, pointed at apex, and with dense punctures. Metasternal triangles with numerous squamiferous punctures. Legs much as in other species of genus. Length, 3 mm.

Malay Peninsula: Gap, on Fraser's Hill (*A. M. Lea*); unique.

The type being unique, and with clothing in good condition, it was not abraded to examine the sculpture of the elytra, but these appear to have rows of fairly large punctures in narrow striae on the sides, and are apparently striated only near the suture. As the elytra could not be forced apart without risk of breaking them, the wings were not examined, but they are probably rudimentary. Most of the scales on the upper surface are of a dingy brown, but there are some obscurely darker spots; on the pronotum there are five small whitish spots, a medio-basal one, one each side about the middle, and one near each coxa (the latter not visible from above); on each elytron there is an oblique spot about the basal third, the two appearing as if remnants of a V; on the legs the scales are obscurely mottled. In general appearance the insect is close to some of the squamose and setose species occurring in Australia and various Pacific islands.

Explanation of Plate XVI.

Fig. 1, Antenna of *Ampagia erinacea*; 2, of *A. nigrinasus*; 3, of *A. tarsalis*; 4, of *A.* (*Amydala*) *abdominalis*. 5, Abdomen of *A. abdominalis*; 6, of *Ampagia nigrinasus*; 7, of *A. montivaga*; 8, of *A. rudis*; 9, of *A. leucomela*. 10, Side view of *A. montivaga*; 11, The same, viewed from above; 12, The same, side view of abdomen. 13, Under surface of *A. squamibunda*; 14, front leg; 15, middle leg; 16, hind leg; 17, hind femora at rest, viewed from behind; 18, intercoxal process of mesosternum viewed from behind. 19, Hind femur of *A. leucomela*; 20, of *A. sordida*. 21, Rudimentary wing of *A. obscura*. 22, Outline of upper surface, viewed from the side, of *A. basicollis*; 23, of *A. vitiensis*.



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THE GENUS *AMPAGIA* (CURCULIONIDAE).

A CONTRIBUTION TO THE STUDY OF MORPHOGENESIS IN THE MUSCOID DIPTERA

By W. R. Thompson, Ph.D., D.Sc.

(Imperial Bureau of Entomology.)

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With Thirty Text-figures.

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I. Introduction.

The present paper, which is an outgrowth of a monographic study of the larvae of some Muscoid Diptera, published some years ago,* comprises (i) an attempt to explain a number of the more obvious morphological characteristics of these creatures as due to the interaction of relatively simple factors, susceptible at least in some degree, to mathematical treatment, and (ii) a discussion of the general significance of the physico-mathematical method as applied to the problems of organic form and movement.

No special effort was made to find material specially adapted for morphogenetic studies. All of the problems here studied suggested themselves naturally during the course of work carried on with a quite different object; every one of them could be made, with profit, the subject of an extensive and extremely interesting investigation. The writer has not the leisure to pursue these lines of research any further, and does not claim for the hypotheses he has ventured to put forward anything more than a suggestive value.

The question of the value of the physico-mathematical method, as applied to biological problems, has given rise to a great deal of vague, though emphatic, argument and confused thinking. It demands a more elaborate and detailed treatment than it is possible to give within the limits of a paper like this.

* 1921. Thompson, W. R., *Bull. biol. France Belg.*, **54**: 313–463, 18 pls., figs.

Nevertheless, it is hoped that the analytical study comprising the second half of this paper, though containing only the bare skeleton of a solution, will help to clear up what is certainly one of the most interesting problems of general biology.

II. Problems Studied.

(*a*) *The Form of the Egg and Larva.*

In order to understand the form of the Cyclorrhaph larva we must first consider the form of the egg, on which to some extent, the larval form depends.

To begin with, we know that the form of the egg is completely determined before it issues from the ovariole. During its passage along the oviduct, and during its descent in the uterus, the only change which the egg undergoes, aside from the embryonic processes, with which we do not propose to deal, consist in the development of the pigment of the chorion, which occurs in the case of the Tachinids which deposit minute eggs on leaves. The efficient causes of the form of the egg must therefore be sought for in the ovariole.

The ovariole of the female adult Muscid is a tubule closed at its distal extremity and opening into its proximal end into the oviduct. The external layer of the ovariole consists of a layer of mesodermal cells, the peritoneal tunic, upon which lies a muscular tunic formed by striated and ordinarily anastomosed fibres, this tunic often being absent at the apex of the ovarian tubes. In the very young pupa, the ovariole has no doubt the form of a simple cylindrical tube filled with undifferentiated cells which later give rise to the ovules, the nutritive cells and the choriogenous epithelium; but even before issuing from the puparium adults of certain species we have examined, like *Sturmia scutellata*, R.D., show ovarioles similar to those of the mature adult, characterised by a series of constrictions, dividing it into chambers, each of which contains an egg-cell with its choriogenous epithelium and a number of nutritive cells. At the distal end of the ovariole there is an unsegmented region, the germinal chamber. In certain insects such as the Hymenoptera, the group of nutritive cells is separated from the egg-chamber by a constriction; but in the Muscids, each chamber, as we have said, contains both sorts of elements, the ovule being always situated in the proximal end of the chamber. Toward the lower end of the ovarian tube, the egg-cells become larger and larger, while at the same time the group of nutritive cells diminishes in size, but in such a way that the entire group of elements contained in each egg-chamber constitutes a physical unit; so that the complications resulting from the presence of several elements in a single egg-chamber may safely be neglected.

As we have seen, there exists on the outer wall of the ovariole a network of muscular fibres. By reason of the presence of these fibres the wall of the ovariole exerts a constant radial pressure upon the contents of the ovarian tube. If one examines the proximal region of the ovariole, after the issuance of an egg, one observes that the diameter of this region has greatly diminished in comparison with the distal region still containing eggs, or in comparison with the homologous portions of the neighbouring ovarioles. In the ovarioles of a female of a *Musca domestica*, L., taken in winter, and examined in a fresh condition, we have observed on the surface of the ovarian tubes, fine longitudinal striations, visible in the regions somewhat distant from the oviduct, but fading out toward the proximal extremity of the ovariole, where the dimensions of the eggs were greater. These striations we believe to be delicate folds resulting from the contraction of the muscular wall.

Again, no matter what be the form of the egg-chamber in the proximal part of the ovariole, in its distal portion, in all the species we have examined (*Miltogramma punctatum*, Meig., *Zophomyia temula*, Scop. (Fig. 1), *Frontina frenchi*, Will. (Fig. 2), *Ernestia radicum*, Fabr., *Tachina rustica*, R.-D., *Sturmia scutellata*, R.-D. (Fig. 3), etc., this form is that of a simple sphere, or of a sphere slightly

Fig. 1.—Ovariole of *Zophomyia temula*, Scop.

Fig. 2.—Ovariole of *Frontina frenchi*, Will.

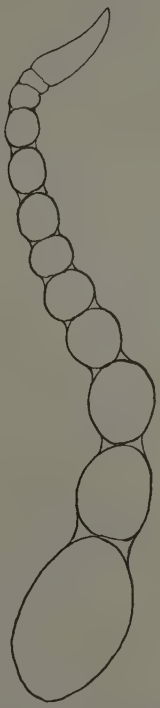

Fig. 3.—Ovariole of *Sturmia scutellata*, R.-D.

flattened in the direction of the longitudinal axis of the ovariole; or at all events there exists in this region a strong tendency to the spherical form, from which the egg-chambers of the various species derive by special and specific modifications.

The initial morphogenetic processes, whereby the form of the egg arises, thus appear to be somewhat as follows. At a given moment, there issues from the terminal chamber of the ovariole a group of cells comprising an egg-

cell and a certain number of nutritive cells. As soon as it has issued, this group of cells—which behaves, as we have said, as a coherent and undivided whole—will have a tendency to assume a cylindrical form, on account of the radial pressure exerted upon it by the wall of the ovariole. But according to the well-known physical law, this physical system will also tend to arrange itself in such a way that its surface energy is the least possible, under the prevailing conditions; that is to say, in such a way that its surface is a surface of minimal area, of which the spherical surface is a perfect type.

An equilibrium is thus established between the tendency of the cell-complex toward the spherical form and the radial pressure of the wall of the tube in which it lies. Finally, the pressure of the cell-groups at either end of the egg-chamber also comes into play. The combined action of these several forces determines, as nearly as we can tell, the form of the egg. According to the

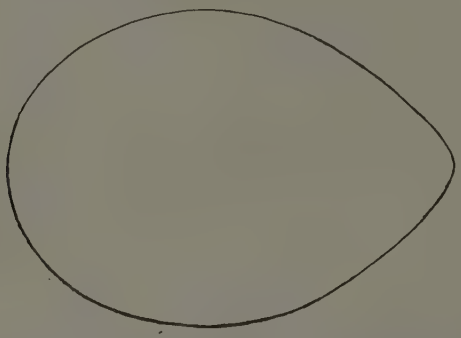

Fig. 4.—Egg of *Sturmia scutellata*, R.-D., from the dorsal side.

intensity of each of the separate forces involved, we shall thus have egg-chambers having the form of spheres, cylinders with spherical caps, or spheres or cylinders with flattened ends. For example, if the dimensions of the complex within the egg-chamber are relatively small, its form will be more nearly spherical for a given radial pressure than will that of a larger complex, which will tend to the cylindrical shape. In this way arise such different conditions as those figured by J. Pantel * for the ovules of *Tricholyga major*, Rond. (spherical chambers) and *Blepharidea vulgaris*, Fall. (truncated ellipsoids).

As the egg and its attendant nutritive cells descend along the ovarian tube they increase in volume, and during this period there occurs, so to speak, a struggle between the various physical forces coming into play, on the result of which depends the final form of the egg.

If the increase in size of the contents of the egg-chamber is not very marked for a given pressure of the wall of the ovarian tube—whose diameter increases towards its proximal end—the egg-chamber will retain an approximately spherical form. Such is the condition we find in the ovarioles of species depositing "microtype" eggs, such as *Sturmia scutellata*, R.-D. (Fig. 4). If for the same given pressure, the increase in the volume of the egg-chamber is more rapid, and if no special conformation of the membranes of the egg-chamber exists to oppose it, the chamber will tend to take on a more elongate form, such

* 1910. *La Cellule*, **26**: 25–216, 5 pls.

as that of an ellipsoid, which is the case most frequently met with (Fig. 1, *Z. temula*; 2, *F. frenchi*).

The action of the forces which thus determine the form of the egg can be represented, according to Professor D'Arcy Thompson,* by means of a mathematical formula, to wit :—

$$p_n + T(1/r - 1/r') = P$$

where p_n is the normal component of external pressure, at a point where r and r' are the radii of curvature, T the tension of the envelope of the egg, and P the internal fluid pressure. If T is constant and symmetrical about the axis of the egg, or in the case we are studying, of the egg-chamber, this latter will have a symmetrical form. From an asymmetry of T there will result an asymmetry in the form of the egg. Again, from an asymmetry of p_n, *i.e.* of the pressure of the wall of the ovariole, the same condition will result. A little consideration of this formula readily enables us to understand cases more complex than those we have heretofore considered. For example, the eggs of Tachinids belonging to Pantel's Group I (species depositing large eggs upon the body of the host, like *Tachina rustica*, R.-D.) have already in the lower part of the ovarian tube the characteristic asymmetrical form, which is that of a hemi-ellipsoid, *i.e.* of an ellipsoid of revolution divided along its longitudinal axis. The eggs of species depositing minute eggs on leaves also finally come to have this form. In these cases, the final cause of the form of the egg has especially attracted the attention of observers. Not only is the egg admirably adapted to be affixed to the skin of the host; but further, a certain number of physiological and anatomical peculiarities which it exhibits—solidity of the outer surface, secretion of a cement whereby the underside of the egg is glued to the leaf upon which it is deposited or to the skin of the host—concur toward the same end and impress upon us the adaptive significance of the form. Nevertheless, the discovery of the final cause does not exhaust the subject; and in no way replaces, as some naturalists would seem to imagine, the demonstration of the efficient causes of the form, which appears to result as we have seen, from a relatively simple variation in the mode of action of the simple physical forces indicated in the mathematical formula cited.

We cannot at present undertake a thorough study of egg-formation in the higher Diptera, though there is here a rich field for investigation, particularly among the parasitic forms. But we may consider briefly as an example the egg of *Tachina rustica*. As we have mentioned, this egg is flat on one side and convex on the other, and is attached to the host by the lower plane surface. Now putting aside all teleological considerations, and taking the formula given by Professor D'Arcy Thompson as embodying in a broad general way the explanation of all cases of egg-formation, we are led to the conclusion that the cause of the form of the egg we are studying must be sought for in the ovarioles.

When these are examined, it is seen that in their distal region the ovules are circular in transverse section and the choriogenous epithelium is apparently of uniform thickness. As one approaches the proximal extremity of the ovariole, however, one finds that this epithelial layer becomes a little thicker on one side of the egg than on the other; and that the secretory activity of the cellular layer in question is greater on the thick side than on the thin, producing a heavier layer of chitin. The peritoneal membrane appears to be of uniform thickness throughout; though we are inclined to believe that it is to differences

* 1917. *Growth and Form*, Cambridge.

in the tension of this membrane on different sides of the ovariole that the differences in thickness of the choriogenous epithelium is due. However this may be, the few facts already mentioned suffice to explain the final form of the egg. Let ABCD in Fig. 5*a* be the wall of the egg filled with an incompressible liquid, ACB the thick half of the egg-shell and ADB the thin half. If we now apply a uniform radial pressure about the circumference ACBD the semi-circumference ADB will tend to flatten more rapidly than the semi-circumference ACB, so as to become a straight line, while the curvature of the side ACB will simply become a little more shallow; or in other words, the radius of curvature of ADB will increase in length more rapidly than that of ACB. We shall thus obtain the successive phases represented by *b* and *c* of our diagram, Fig. 5, *of which c corresponds almost exactly to the cross-section of the egg of Tachina rustica.*

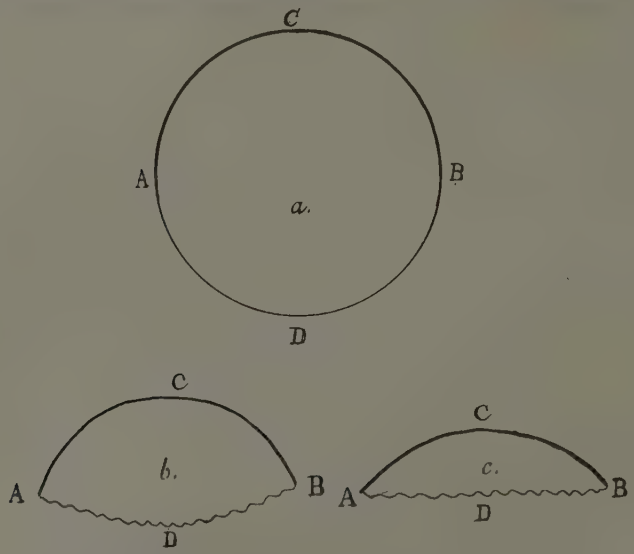

Fig. 5.—Successive stages in the formation of the egg of *Tachina rustica* (semi-diagrammatic).

In the diagram *b* and *c*, ADB is shown as an undulating line; or in other words, the underside of the egg is thrown into longitudinal folds, as it assumes its final form, *and these folds actually exist in the under surface of the developing egg of the species studied.* If one of the eggs of this type is boiled in potash until the chorion is soft, it assumes an almost spherical form (*Tachina larvarum*, L.). Again, if we examine in an almost completely formed egg the epithelial cells adjacent to the line ABD, we find that these have become more elongate than those upon the opposite side of the egg; their cytoplasm being full of vacuoles, so that they resemble the " cellules claires " in the pharynx of certain Muscids (*vide* Pantel * and Thompson †). The character of this part of the epithelium is evidently determined by the deformation of this half of the egg-membrane,

* 1898. *La Cellule*, **15**: 1–290, 6 pls.
† 1921. *Bull. biol. France Belg.*, **54**: 313–463, 18 pls., figs.

from which there result radial mechanical tractions on the epithelial cells analagous to the muscular tractions which are the determining causes of the production of the " cellules claires " in the Muscid pharynx.

It must be admitted that the explanation given is not complete, since we know nothing as to the causes which produce the thickening of the choriogenous epithelium on one side only. It may be that, as already suggested, this depends in its turn on the fact that the pressure of the wall of the ovariole is not originally absolutely symmetrical in relation to the egg-chamber; but no morphological evidence of such asymmetry has been detected.

The form of the first-stage larva depends to some extent upon the form of the egg, and in some cases appears to derive directly from it; and thus ultimately depends upon the physical forces acting in the ovarian tube. Thus the larva of *Zophomyia temula* (Fig. 6*a*) differs from the larva of *Ernestia radicum* (Fig. 6*b*) in the same way as do the lower egg-chambers of these two

FIG. 6.—(*a*) General form of the larva of *Zophomyia temula*, Scop.; (*b*) of the larva of *Ernestia radicum*, Fabr.

species. In other instances, however, the larval form seems to develop without any special relation to the mechanical restraints imposed upon the rigid shell. For example, the larvae of species depositing minute eggs on leaves, so long as they are within the egg, appear to be very short and stout; so that Townsend,* who examined larvae which he believed to be free from the egg membranes, but which were in reality still surrounded by the vitelline membrane, described them as utterly different from the larvae of all other Tachinids; but as Pantel pointed out (1910), the form of the larva after hatching is quite different from that of the egg, and similar to that of the majority of Tachinid larvae. Nevertheless, although not so remarkable as Townsend believed, the effect of the form of the egg on the form of the larva is none the less real, as can be seen by comparing the two outline figures of the larvae of *Phorocera doryphorae* and *Masicera senilis*, Rond. (Figs. 7*a*, *b*). The first of these deposits a short oval microtype egg; the second an elongate cylindrical egg. And the differences in the larval form are of the same general order.

In certain cases these differences in the form of the egg and of the first-stage larvae seem, as it were, to exert an influence throughout the whole of the life-history. For example, most adult Dexiids are like their larvae, elongate and slender; the puparium of *Sturmia scutellata* is short and stout, resembling a hen's egg in form, with the posterior extremity broadly rounded, and the anterior end more pointed—like the primary larva and the egg of this species. But in

* 1908. U.S. Dept. Agric. *Bur. Ent.*, Tech. Ser. 12, Pt. VI.

very many cases there is no obvious relation between the form of the egg and that of the puparium, or between the form of the puparium and that of the adult; and from the few special cases we have cited no definite conclusions can really be drawn.

(*b*) *The Form of the Puparium.*

Few objects are more familiar to students of entomology than the cylindrical or ovoid dark-coloured puparia of the higher Diptera. The manner in which they are formed has frequently been described. Nevertheless, not even the authors who have specially studied the larvae of Diptera and the processes of metamorphosis seem to have attempted an explanation of the form of the puparium.

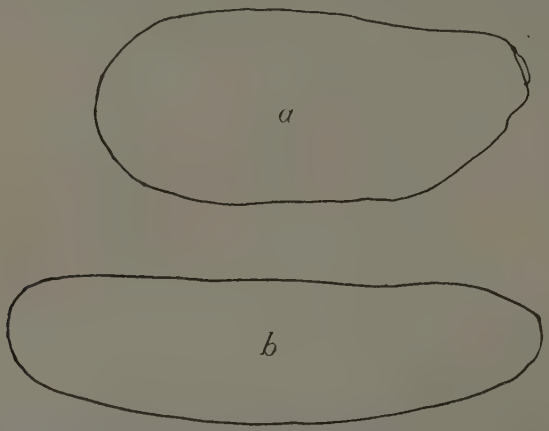

Fig. 7.—(*a*) General form of the larva of *Phorocera doryphorae*, Riley; (*b*) of that of *Masicera senilis*, Rond. (var.).

The process of pupation in the Muscid flies occurs somewhat as follows. At a certain moment, after it has finished feeding, the adult larva ceases to move about and contracts, withdrawing the head and anterior segments, so as to assume the form of an ellipsoid of revolution, which is at first irregular, owing to the continued though slight contractions of the segments and the consequent wrinkling of the body wall. Little by little, even these slight and superficial movements die away and cease. The surface of the body becomes smooth and the general form that of a regular ellipsoid. At this moment the surface of the body is already harder to the touch than that of the larva. This hardening of the integument becomes more marked and is accompanied by a change in coloration. From milky white, the puparium turns gradually to light or dark brown, sometimes even to black. The whole process, which is now complete, occupies in *Musca domestica* about six hours according to Hewitt, but in the case of many Tachinids much less time is required.

The morphological characters of the puparium which chiefly interests us are (1) its form, which is that of a regular ellipsoid of revolution; (2) its surface, which is in general smooth, without indentations or swellings; (3) its colour,

which varies from light-brown to black; (4) the remarkable hardness of the puparial shell.

The form of the puparium in the case of any given species depends upon the form of the adult larva, which is already fairly regular. Again, when, during the course of its life-history, the larva contracts and withdraws the anterior segments, its bodily form, which is approximately conical, becomes that of an irregular ellipsoid. What requires explanation is the formation of a regular ellipsoid of revolution, with a smooth and regular surface where, in many cases, only a microscopic examination will reveal any traces of the convexities which existed in the larva.

In order to understand this change, it is sufficient to point out that it is exactly comparable to the result which we should obtain if we injected a liquid into the body of the larva so as to increase the internal pressure and overcome the muscular resistance. No special mechanism exists in the larval body able to transform the irregular outer surface into a smooth and regular one, the contraction of the integumental muscles having simply as a result an increase in the cuticular irregularities. Nevertheless, this transformation must depend upon the action of some simple force; and the only one which seems capable of producing it is the hydrostatic pressure of the liquid of the body cavity.

When the larva contracts, it withdraws its head into the interior of the body in such a way that on the end of the anterior extremity of the puparium only the first thoracic segment is visible. Now it is obvious that the retraction of the head into the interior of the body at once determines an increase in the pressure exerted by the blood. This pressure, being hydrostatic, is exerted with equal intensity at all points on the interior of the body wall. It thus tends to flatten out over the whole surface all the folds or convexities resulting from muscular activity.

However, against the effects of the hydrostatic pressure another force is normally exerted—the force of muscular contraction, which constantly tends to throw the surface of the body into fresh folds and convexities. At some moment of pupation there must therefore intervene some interior change the effect of which is to annihilate muscular activity or its effects; and, as a little reflection will show, such a result might be determined either (1) by the hardening of the integumental wall, or (2) by a separation between the extremities of the muscle fibres and the hypodermis, or (3) by a degeneration of the substance of the fibres themselves.

Of these possibilities the first may be at once rejected. The hardening of the integument, although it might certainly prevent muscular contraction from producing changes in the form of the body wall, could evidently not prevent the formation of such irregularities as had occurred before the hardening process began. All that can result from this process is the fixation of the surface of the larva in the condition in which it then happened to be. This is, in fact, precisely what happens in certain pathological cases where the mobility of the larva continues up to the hardening phase; so that the puparium is extremely irregular, being in many cases like a larva in form, though hard and dark brown in colour.

We have therefore to choose between the two remaining possibilities, to wit, the detachment of the muscle fibres from the cuticula and the degeneration of the contractile substance. As a matter of fact, during the initial phases of metamorphosis both of these phenomena occur, so that it is very difficult to decide. According to Perez * the hypodermal cells have already become

* 1910. *Arch. Zool. exper.* (5) **4**: 1–274, figs.

detached from the puparial wall in pupae six hours old; but as Pantel (1898) has shown, in the somewhat analogous phenomenon of ecdysis, the muscle attachments are considerably more solid than those of the hypodermal cells. Again, according to Perez, in pupae six hours old (*Calliphora*), the leucocytes already accumulate in the neighbourhood of the muscles and begin to break them down; which indicates clearly, in our opinion, that the degeneration of the muscle fibres is already well under way, whether this is histologically apparent or not.

It is therefore difficult to say which of the two processes in question is of primary importance in the morphogenesis of the puparium. It is possible that both exert an effect. However, in order that the puparium may be perfectly regular, it is necessary that the pressure of the coelomic liquid be maintained until the hardening of the cuticular wall has begun, failing which this pressure would determine a reversion to the form of the adult larva, by the evagination of the cephalic region. It is no doubt to some slight irregularity in the sequence of phenomena involved that we must ascribe the formation of the more or less irregular puparia with which we meet from time to time.

We must now consider the hardening of the puparial wall and the development of its pigment. As a matter of fact, there are good reasons for believing that these two processes are merely two aspects of one and the same phenomenon. In a general way, among insects, rigid integuments or integumental areas are pigmented; and conversely pigmented cuticular areas are rigid. According to Tower, during the formation of the cuticula two kinds of substances are produced; chitin, which hardens to form a rigid shell, and an amido-compound, from which by further modifications there result coloured substances. According to the author cited, there exists, between the degree of rigidity and the intensity of pigmentation, a direct proportional relation. The enzyme which acts upon the cuticula produces simultaneously hardening and pigmentation.

The question is, why such a process occurs at a certain moment of metamorphosis. Here, again, the attention of biologists seems to have been especially attracted by the fact that the production of a rigid envelope at this time is beneficial to the individual, which is thus protected during the delicate and critical phases of histolysis and histogenesis. But this explanation, whether it be valid or not, has obviously nothing to do with the type of causality which we are considering in this paper. Here we are seeking to determine, not the final, but the efficient or physico-chemical cause of the phenomenon we are discussing. We cannot formulate at present a complete and detailed explanation of this order. But we can at least gather together a number of data which seem to throw some light on the problem.

According to Dewitz, quoted by P. Marchal,* the coloration which develops in Muscid pupae at the moment of pupation is due to the presence of an oxydase analogous to tryosinase and acting on a chromogenous substance which is found in the blood. These principles are identical with those which exist in the blood of the larva, and which, in contact with the air, determine the blackening of the semi-fluid material obtained by grinding up the body of the animal. This darkening of the blood is a phenomenon which forces itself on the attention of everyone who has occasion to dissect insects, the organs of which gradually darken on exposure to the air. Again, the tracheal or integumental sheaths which form around the posterior extremities of Tachinid larvae (after the perforation of the tracheae or integument of the host, as a result of the proliferation of the tracheal or hypodermal epithelium, accompanied by an abnormal secretion of chitin) are almost always

* [1911.] Marchal in *Richet. Dict. Physiologie.* Paris, **9**: 278.

dark brown or black in colour, especially in the basal region. Finally, in the points where the body wall of a caterpillar has been pierced by the ovipositor of a parasite, or wounded in any other way, there forms on the cuticula around the wound a pigmented zone more heavily chitinised than the normal areas.

From these several facts we seem naturally led to conclude that the pigmentation and hardening of the puparial wall is a phenomenon comparable to that which is determined in soft-bodied insects as a result of injuries of the hypodermal cells. For the idea of injury we may substitute that of excitation, and ask ourselves what excitation of the hypodermal cells occurs during the preliminary phases of pupation capable of producing the phenomenon with which we are dealing. The only obvious process of this sort would seem to be the mechanical excitation produced during the gradual detachment of the hypodermis from the larval cuticula. The question then arises, why a hardening and pigmentation of the cuticula does not occur during the process of the moult, which seems to some extent quite comparable. This question is difficult to answer; but it seems at least possible that the difference in the result of the larval and pupal moults may depend, on the one hand, on the particular way in which the hypodermis becomes detached from the cuticle and, on the other, on the pathological condition of the larval epithelium, which is already at this time undergoing the preliminary phases of histolysis.

Thus to sum up, the morphogenesis of the puparium seems principally to depend on (1) the contraction of the larva, from which results (2) an increase in the hydrostatic pressure of the coelomic fluids, and (3) on the detachment of the hypodermis associated with (4) a degeneration of the integumental muscle fibres; there thus results a regular ellipsoid form, with a smooth surface, which is fixed by the transformation of the larval integument into a hard and rigid shell. Later studies will perhaps show to what extent these several factors may be considered as constituting the efficient cause of the form of the puparium. Here as elsewhere in this paper, we have made it a rule to begin with the simplest possible explanations of morphogenetic processes, because this seems to us the best method of approaching the subject with which we are dealing; but we shall be neither surprised nor disappointed if our explanations are shown by later workers to be inadequate.

(*c*) *The Surface of the Larval Body.*

(i) *The pseudopodia or integumental protuberances.*

As we have shown in another paper (1921) dealing with the larva of *Miltogramma punctatum*, the integumental protuberances are simply shallow evaginations of the body wall, composed of a layer of cuticula lined by the integumental epithelium. The number of these protuberances is constant and regular. In parasitic larvae they are as a rule evanescent; but in free-living larvae they are usually well developed. They are of two sorts, for some bear sensorial organs, while others contain muscular insertions. The latter usually bear also spines or hooks and function as pseudopodia. The nervous protuberances each contain a bulb of mixed hypodermal and nervous origin, which supplies a sensorial organ.

The muscular protuberances, as we have said, exist only around the extremities of the muscle fibres. Along the intersegmental lines they are usually absent, nor do they exist around the intrasegmental extremities of the oblique fibres which are attached anteriorly to the inner surface of the abdominal

segments in the mid-dorsal region. Finally, in the thoracic region they are nowhere clearly evident, at least in the larva of *Miltogramma punctatum*. The only regions in which they are to be found are those where the extremities of extremely powerful fibres terminate in the midst of an otherwise unoccupied space. For example, the latero-ventral band of straight and oblique fibres * as well as the circular intrasegmental band terminates at some distance from the median ventral line, leaving on either side of the latter a sternal area in which are found the principal pseudopodia (Fig. 8). Of these *a*, in the middle of the anterior border, receives the posterior extremity of the oblique sternal muscle *24*, of each side; in the same way, *d* and *f* receive the extremities of the muscles *23* and *25* of each side; and in *f* is also inserted the posterior extremity

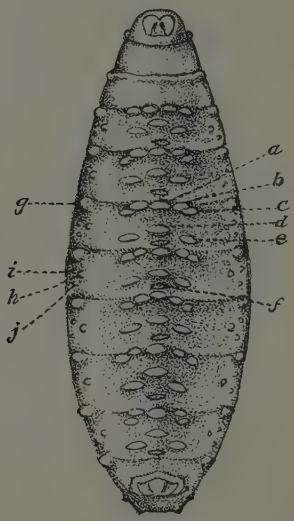

Fig. 8.—Larva of *Miltogramma punctatum*, Stage III, ventral aspect, showing the integumental protuberances on pseudopodia.

of the oblique sternal muscle *22*; *b* receives the median branch of the trifurcated muscle *18*, and it is also traversed by the little circular ventrolateral muscle *26*, terminating in *c*, which also receives the extremity of the inferior branch of *18* (18*c*); *e* is a musculo-nervous protuberance; it receives the anterior end of the short muscle *21* and the upper branch of *18* (18*a*), and on it there occur three secondary evaginations bearing sensorial organs. Finally, the great pleural pseudopodium *g* is traversed by the intersegmental muscle *12*.

Thus, in almost all cases, the muscular protuberance is developed around the insertions of several powerful muscle fibres which terminate in the midst of an otherwise unoccupied area of the integument. It is not surprising that protuberances form at these points. Wherever the traction of the muscle fibres is exerted, the surface of the integument, originally uniform and plane, is pulled inward in a fold or invagination. Along the intersegmental lines

* *v.* Thompson, 1921, *l.c.*, Pl. VI, fig. 3, Pl. VIII, fig. 16; or 1928, *Parasitology*, **22**: 133, fig. 1, and Pl. VII, fig. 5.

there forms only a fold; but where muscular traction is exerted in an isolated integumental area, its effect is individualised. At first sight it might seem that the result of the traction should be to produce an integumental depression. But it seems probable that its real effect is simply a local dilatation of the skin, which becomes a convexity under the action of the hydrostatic pressure of the blood, during the time when the cuticula is hardening.

If one compares the dimensions of the "pseudopodia" in the larva of a given species with the dimensions of the muscular fibres inserted in them, one observes that there is a fairly well-defined relation between the two, the larger of the pseudopodia being those which receive the most powerful muscles. Again, if one compares a free-living larva, such as *Miltogramma punctatum*, with a parasitic larva, such as *Melanophora roralis*, which lives in wood-lice, one notices that although the integumental muscular system is essentially similar, yet in the parasite the cuticular protuberances are practically absent, while in the non-parasitic larva they are well developed; and that in *Melanophora* the muscle fibres are weak and slender in comparison with those of *Miltogramma*. It seems therefore that the force of muscular traction exerted on the integument while the cuticula is in process of formation, together with the radial hydrostatic pressure exerted by the body fluids, constitute the principal factors responsible for the appearance of the pseudopodia.

As for the sensory papillae, formed by a little evagination lined by several epithelial cells, surrounding the bulb of a sense organ, their formation depends in all probability on the intercalation of the large nerve ending between the hypodermal cells; as a result of which the integument is thrown into a slight convexity at the point in question. Here as before the first effect of the intercalation of the nerve-ending would probably be the production of a depression or dimple, were it not for the effect of the internal pressure of the blood.

Supposing that this simple explanation of the formation of the muscular and sensory pseudopodia be correct, it does not of course follow that these organs have not also a teleological significance. The pseudopodia function in the one case as ambulatory organs; and in the other case as sensory organs. But this simply constitutes in our opinion an example of the fact that the forces acting on the organism determine their effect in something whose peculiar property it is to obey the laws of physics in a way advantageous to its own well-being.

(ii) *The cuticular scales and spine bands.*

The cuticular scales in a larva like that of *Miltogramma punctatum* are local modifications of the cuticle, having the form of small triangular or oval plates, attached at the base to the integument. Seen in longitudinal section, the scale resembles the rest of the integument in its general structure, being composed of two layers of cuticula, primary and secondary, together with a lining of epithelium. In certain species the scales are pigmented; in others they are colourless; or they may be pigmented in one stage of the life-history and colourless in another, as in the case of *Sarcophaga falculata*. These formations exist in almost all Muscid larvae, and their functional significance is considerable. The study of the causes which determine their apparition and arrangement thus constitutes an unusually interesting problem.

At first sight the cuticular scales of the *Miltogramma* larva appear to be distributed without regularity, but on careful study it is seen that this is far from the truth. For example, in the first stage larva of *Miltogramma* the bands of spines are arranged in a definite manner, which is briefly as follows :—

a band exists on the anterior border of segments I and II and on the anterior margins of the segments following; but on the fourth segment some isolated elements appear on the posterior border, and on the segments following the number of these progressively increases, so that in front and behind the intersegmental lines IX–X and X–XI about the same number of scales exist. Again, as one proceeds from the anterior to the posterior regions of the body, the anterior bands progressively diminish in width. For example, on segment IV the band of scales occupies the anterior third of the segment, and on the three following segments it diminishes. It covers on segment VII only the anterior fourth and on segment VIII only the anterior fifth; the segment IX bears on the anterior border only a few separated groups of scales, and there are still less on the corresponding region of segment X.

In short, in a general way, in practically all the larvae of this group which we have had occasion to examine carefully, the spine bands on the anterior border of the segments are especially well developed on the anterior regions of the body, and diminish progressively in width in the posterior regions; and at the same time the bands on the posterior border of the segments, which usually appear on the third or fourth segments, become broader and broader. A good description of an arrangement of this kind has been given by D. Keilin * in his account of the larva of *Onesia sepulchralia*.

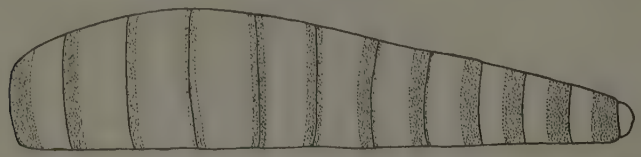

Fig. 9.—Diagrammatic representation of the arrangement of the cuticular spine bands in a Muscid larva. The anterior end is directed toward the right-hand side.

The differences noted in the distribution of the spines of the different regions of the body have a definite relation to the general change in form; the diameter of the larva increases progressively posteriorly, until the beginning of the posterior third of the body, and from then on diminishes, but relatively slightly, to the posterior extremity; and in the middle of the body several segments are approximately of the same diameter. We can thus represent the general distribution of the spine bands by a diagram like that shown in Fig. 9.

But the integumental scales are not to be found simply on the border of the segments; they exist also on the integumental protuberances, though only upon those which contain muscular insertions. In general the number of scales existing on a pseudopodium appears to bear a fairly definite relation to the size of the latter and especially to the degree of its convexity.

Again, if we examine carefully any individual spine band, for example the band on one of the anterior segments, we find that the dimensions of the individual scales bear a more or less definite relation to their distance from the intersegmental conjuctiva, the largest scales being nearest the margin of the segment, the scales which are more remote being smaller. It is rather difficult to make exact calculations, but a careful examination of the anterior spine bands of the *Miltogramma* larva has shown that the size of the scales really does vary almost exactly in inverse proportion to their distance from the margin of the segment.

* 1915. *Bull. sci. France Belg.* (7) **49**: 15–198, 16 pls.

Let us now consider the individual scales. Here again the irregularity of distribution is merely apparent. In *Miltogramma punctatum* (Fig. 10), the scales are distributed in groups of several elements (3 to 6 or more) arranged along a curved line whose concavity is directed toward the segmental margin. In *Sarcophaga falculata* a similar arrangement exists; but here the curved lines are longer and the individual groups are less distinct.

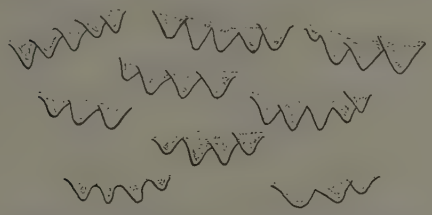

FIG. 10.—Arrangement of the cuticular scales in the larva of *Miltogramma punctatum*, Stage III.

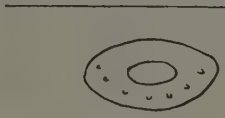

FIG. 11.—Hypodermal cell, scales and intersegmental line in *Miltogramma punctatum*, Stage III.

In order to understand the significance of the arrangement of the individual scales, we must determine their relation to the hypodermal cells. We then observe, in the *Miltogramma* larva, that the curved line of scales is situated almost immediately above a hypodermal cell (Fig. 11) and follows a course parallel to the border of the cell which is furthest from the margin of the segment. In *S. falculata* (Fig. 12), on the other hand, only a single isolated scale occurs above each separate hypodermal cell, being situated usually immediately above the nucleus. In this case the curved lines of scales have no relation to the form

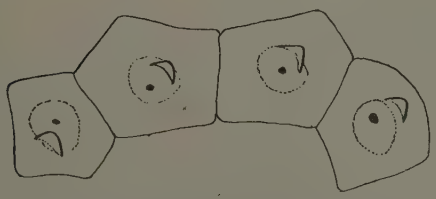

FIG. 12.—Hypodermal cells and scales in *Sarcophaga falculata*, Pand., Stage III.

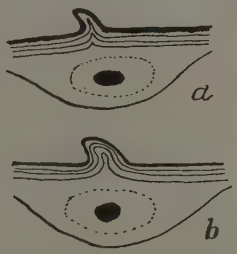

FIG. 13.—(*a*) Section of an integumental scale of the larva of *Miltogramma punctatum*; (*b*) of a temporary fold in the skin; to show the difference in the disposition of the cuticular layers.

of the individual cells as in *Miltogramma*, but are in relation with rows of cells, being arranged along curved lines joining the nuclei.*

* This simple fact is of some interest in connection with the so-called "cell-theory," according to which the activity of an organism is merely the resultant of the interaction of a multitude of almost independent plastids or units, forming what is often called the cell-republic. It is sufficient to compare the cases of *Miltogramma punctatum* and *Sarcophaga falculata* to see that the production of scales arranged in curved lines with the concavity directed toward the intersegmental line—in short, the production of a certain specific morphological result—even in the case of two species in the same systematic group, may be the work of either a single cell or a series of cells.

If we examine carefully a section of an integumental scale of *Miltogramma punctatum*, we shall see that it is principally formed by layers of secondary cuticula, although as a matter of fact the primary cuticule is thicker on the scales than on the rest of the integument. In longitudinal section the scale appears as a kind of integumental fold, into the underside of which the cytoplasm of the hypodermal cell is very slightly prolonged. The angle of the fold of the successive layers of the secondary cuticula becomes larger and larger or more and more obtuse as one passes from the primary cuticula to the hypodermal cell (Fig. 13). If one examines a series of longitudinal sections of a single cell of *M. punctatum* one finds that the cytoplasmic projection opposite the scale is practically continuous, forming a fold which runs along the outer surface of the cell, parallel to its posterior border (Fig. 14).

Before attempting an explanation of the morphogenesis of the scales it seems worth while to consider more precisely the significance of the topo-

Fig. 14.—Series of sections of a scale-forming hypodermal cell of *Miltogramma punctatum*, Stage III, to show the ridge on the outer (sub-cuticular) surface.

graphical analysis which we have just completed. As we have seen, the distribution of the cuticular scales, which at first sight seemed to be quite irregular, can be fairly exactly defined, by means of a series of simple and analytical operations. The bands and the islands of scales occupy well-defined regions; the size of the individual scales depends on their place in the band; the individual scales are arranged in groups of a certain form, having a fixed relation to the segmental margin and composed of elements whose number varies only within narrow limits; finally, there exists between the groups of scales and the hypodermal cells a quite definite relation, the situation of the groups depending on that of the epithelial elements. The distribution of the scales is thus not truly irregular, since it follows laws which can be simply and easily defined.

Such is probably also the case for many other structures whose arrangement appears to follow no special rule, simply because we have not studied them with sufficient care. Every biologist knows, for example, that taxonomists constantly distinguish between constant and variable characters, of which the former alone serve as a basis for specific distinctions; so that the idea of an essential difference between these two types of characters naturally arises.

In many cases, however, this may be a mere illusion. The organs considered as variable are in many cases those which are most numerous; and their apparent variability is largely due to the fact that according to the laws of probability the forces determining a slight variation in the case of an individual organ have naturally a much greater effect when the organs are numerous.

For example, suppose that we have four organs, A, B, C, and D, distributed as in Fig. 15 so that each organ can move within the limits of a compartment containing 9 divisions; and suppose that A and D are of the form O and B and C of the form X. We can arrange each organ in nine ways, and each arrangement of any one can be associated with any arrangement of the others, so that we have in all 6561 possible arrangements. This number is large, but in

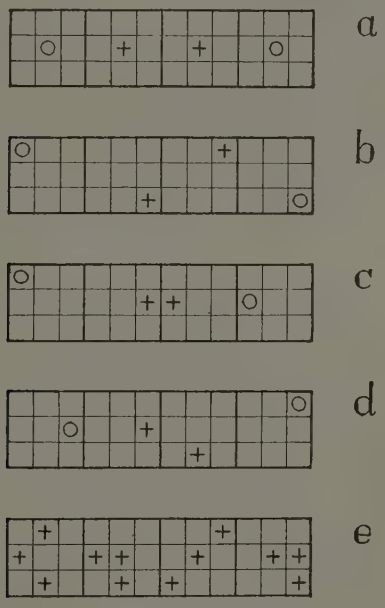

Fig. 15.

reality it may be of little importance, because of the essential similarity in form and arrangement. For example, in each of the four cases shown in Figs. *a* to *d*, we can always define the arrangement as a series of four organs situated in a given area, disposed in a more or less regular transverse line, the outer elements being always of the form O and the inner elements of the form X.

But if the number of organs in each compartment rises to 3, then the number of the possible arrangements will be so great that no definition will be possible, especially if to the variation in position there be added a variation in number.

Thus between what are called constant and what are called inconstant characters, there may not always be any essential difference; the same laws of variability acting on large lots will inevitably produce an irregularity of distribution and an inconstancy which will not be apparent when only a small number of organs is present.

If we compare a section of the integument of a Lepidopterous caterpillar with that of the Muscid larva, we shall find that in the caterpillar the trichogenous cells, which secrete the sensory hairs, differ greatly from the ordinary hypodermal cells; but in the Muscid larva the cells which generate the cuticular scales differ in no way from the ordinary hypodermal elements, except for the fact that they present on the outer surface a slight ridge opposite the base of the scale. Are we to suppose that there nevertheless exist between the scale-producing cells and the other hypodermal elements differences which are not morphologically or cytologically visible? To do so would be equivalent to admitting that the efficient causes of the production of the cuticular scales are inaccessible to investigation. We shall therefore begin with the hypothesis that the hypodermal cells producing scales are essentially similar to those of the rest of the integumental epithelium.

In this case, since the cuticula covering the scale-secreting cells differs from that secreted by the ordinary epithelium, the difference must be due to extrinsic causes determining two different modalities of cellular activity.

A first glance over the available data shows that there is a definite relation between the presence of scales and the attachment of the integumental muscle fibres. Cuticular scales do not occur near all the muscle insertions, but they do not occur anywhere else. From this it appears that the efficient cause of scale production is not merely muscular traction. The mechanical force exerted at the posterior extremity of the thoracic muscle fibres, for example, must be equal to that exerted at their anterior extremities; yet scales are here formed only above the anterior ends of the muscles. Again, the posterior dorsal muscles do not differ in any way from the dorsal muscles of the anterior region, but the scales exist on the dorsal surface of the thoracic segments and are practically absent on the last abdominal segments.

The idea then naturally arises, that if the formation of the scales is not directly determined by muscular traction, perhaps it is due to an excitation of the hypodermal cells, resulting from the friction of the regions of the integument adjacent to the integumental conjunctivae during the contraction of the larval body. As we shall see, there is some truth in this idea. Nevertheless, if the mere friction of two adjacent regions of the body were sufficient to determine the production of the scales, these ought to exist in all cases both anteriorly and posteriorly to the intersegmental lines; since, during the phase of contraction, the two regions which come into contact are equally stimulated so that the behaviour of the hypodermal cells should be in both regions the same. But, as we have seen, in the anterior regions of the body the scale bands exist only on the anterior margins of the segments.

If we now examine with care the form of the scales, we notice, as has already been mentioned, that they differ little in structure from the normal integument, and appear in longitudinal section simply as integumental folds, of which the outer layer (primary cuticula) is simply a little thicker and more strongly pigmented than that of the ordinary integument. However, this fold differs from those which are caused by mere passing local contractions, in that the angle made by the successive layers with the surface of the body becomes broader and broader as we proceed from the outer to the inner layers; while, in the case of the transitory folds, this angle is constant. (The two figures 13*a* and 13*b* will make clear the difference.) In other words, the structure of the scale is precisely such as would result if it were in fact in the initial stage of its formation, a simple cuticular fold, fixed by the hardening of the primary cuticula, below which had been subsequently deposited a series of secondary cuticular

layers. By reason of their thickness, the layers of secondary cuticula deposited would naturally and inevitably approximate more and more closely to plane surfaces.

The structure of the scales thus indicates that they are in the initial stages of morphogenesis, local folds of the primary cuticula. How are these folds produced?

In order to answer this question, we must call to mind the fact that in the anterior segments of the larva the scale bands occur on the anterior borders; that the size of the individual elements varies in inverse proportion to their distance from the intersegmental conjunctivae, and, finally, that the apices of the scales behind the conjunctiva are directed backward. It therefore follows that the forces which determine the production of the scales must (1) act on the anterior border of the anterior segments, (2) diminish in intensity as one passes from the conjunctiva toward the middle of the surface of the segment, and (3) determine the formation of scales in such a way that their summits are directed toward the middle of the segment and not toward the intersegmental line.

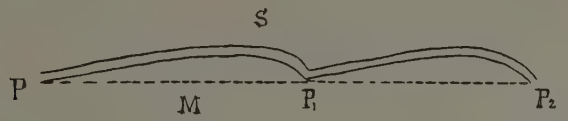

FIG. 16.—M, muscle; P, P_1, P_2, borders of the segments (S).

Now the only phenomenon which seems capable of producing simultaneously all these results is the inflexion of the anterior border of the segments during the contraction of the larva.

When the anterior region of the larval body contracts—since the diameter of the segments in this region becomes progressively less anteriorly—the posterior border of each segment is withdrawn into the anterior border of the preceding segment, as into a collar. The diagrams of Figs. 16 and 17 will make clear the various phases of this movement. In the contraction of the segment *S*, for example, the point *P* remaining fixed, the muscle *M* contracts and the anterior border of the segment *S* is inflexed downward, inward and backward, assuming successively the aspects shown in Fig. 17*a*, *b* and *c*. On the other hand, the posterior border of the segment immediately in front of *S*, like the posterior border of *S* itself, remains flat, being inflexed neither in contraction, because of the traction of the muscle *M*, nor in expansion, since this is due to the combined effects of the intrasegmental muscle bands and the hydrostatic pressure of the body fluids; the result being a flattening of the surface of the segments.

From the inflexion of the anterior border of the segment there results a compression of the integument in that region, and from this compression there arise, according to our hypothesis, slight local folds of the outer surface of the hypodermal cells, on which the cuticular scales are formed. It is evident that the compression of the hypodermal cells will not be equal for all of the elements near the margin of the segment. The cells most strongly compressed will be those opposite the point marked *Max* in the diagram; and, as we proceed posteriorly from this point toward the middle of the segment, the antero-posterior compression of the cells will become less and less, following a law of which the curve of the segmental border, as represented in the drawing,

forms a kind of rough graphical representation. And as we have seen, the dimensions of the individual scales decrease progressively in exactly the same way, from the anterior to the posterior regions of the band.

However, at this point an objection may be raised. The cells of the anterior region of the segment, which are nearest to the intersegmental line, that is, in the region below *Max* in the diagram, must be less compressed than those opposite *Max*. Therefore, if our hypothesis really corresponds to the facts, the most anterior scales ought not to be the very largest, but of only moderate size, because during inflexion the curvature of the extreme border of the segment is less pronounced than that of the region a little removed from the border.

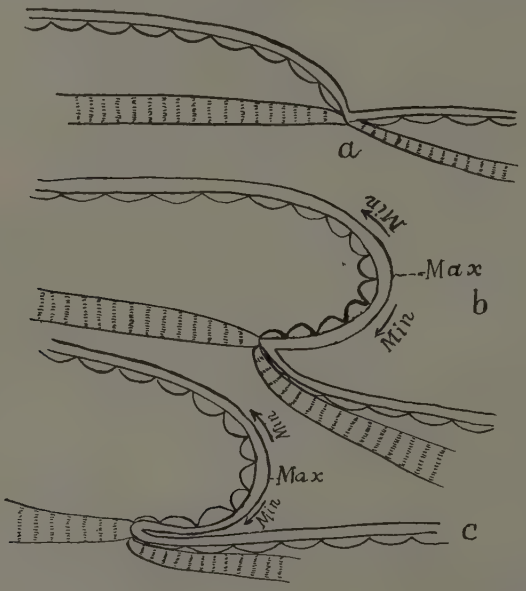

FIG. 17.—Changes in form of the anterior border of a segment of the larval body during contraction; *Max*, point where the effect of the bending process on the hypodermal cell is a maximum; *Min*, directions in which the effect is a minimum.

But as a matter of fact—although this has not so far been mentioned, in order to avoid complicating the discussion—this is exactly what we find. The largest scales are not the most anterior, but those a little removed from the margin of the segment, the anterior elements being of only moderate size. The fact that the scales on the anterior borders of the segments are directed backwards may be readily understood when we remember that, at the moment of their formation, the entire cuticula is still soft. During the inflexion of the anterior border of the segment the surface of that region rolls, so to speak, on the surface of the preceding segment; and this has exactly the same result as if one worked over the scales from before backward with a roller. It is quite probable that at the moment of its formation the axis of the scale is simply perpendicular to the surface of the body, its ultimate position being simply

due to the direction of the pressure which it undergoes during the contraction of the larval body.

So far we have considered only the anterior segments. But the hypothesis here formulated applies equally well to the formation of the scales on the intermediate and posterior segments. In the contraction of the posterior extremity of the larva, the anterior borders of the segments are drawn into the posterior borders of the preceding segments, and it is these which are inflexed. As we have seen, in this region the bands of scales are best developed on the posterior borders, and here the individual scales are anteriorly directed. In the intermediate region—and to a less extent in the posterior part of the body—the change in diameter of the segments is comparatively slight. The inflexion of their borders is therefore little marked and probably occurs in about the same extent on both anterior and posterior borders. Here—and more especially in the intermediate region—there develop bands of spines both in front and behind the intersegmental lines, the scales before the line being directed forward, those behind the line being directed backward.

Again, the lower surface of the larva has a tendency to be flat in profile while the dorsal surface is convex; for this reason, as a little reflexion will show, the inflexion of the segmental margins during contraction is more marked on the ventral side than on the dorsal; and, as we have pointed out, in the intermediate region, where the dorsal convexity is most marked, the bands of spines on the dorsal surface are in general very feebly developed, while on the ventral surface they are well marked.

We have now accounted for the general disposition of the spine bands, the variation in their dimensions, and their individual orientation. But we cannot pretend that we have found an explanation of the formation of the individual scales; that is to say, of the exact cause of the formation on the outer surface of the epithelial cells of the cytoplasmic evaginations over which the scales are formed. This problem is beyond our powers, and we must be content with what is little more than a rough statement of it.

Let us first take the case of *Sarcophaga falculata*. Here only one scale is formed over each hypodermal cell at a point opposite or nearly opposite to the nucleus. As shown in Fig. 12, the hypodermal cells of the *Sarcophaga* larva are polygonal in form, and if a cross-section of the larva be studied it will be seen that both the inner and outer surfaces of the hypodermal cells are plane surfaces.

Now during the inflexion of the segmental margin the hypodermal cells are compressed, and this compression must be exerted in two directions. The dorsoventral inflexion compresses the cell in an antero-posterior direction; but in addition, as the segmental margin is withdrawn backward into the coelomic cavity, the convexity of the invaginating area at the point marked *Max* will also be compressed along the line of the circumference of the larval body, so that each individual cell will be compressed laterally as well as antero-posteriorly. As a result of this compression, the outer and inner surfaces of the cells will be thrown into a convex form. According to the physical law mentioned above, the surface of the cell will constantly tend to the form of a surface of minimal area, and, if the outline of the cell were perfectly circular, this surface might approximate to a small portion of the surface of a sphere. But as it is polygonal it would seem that there would be a tendency for the surface to assume a more or less pyramidal form, in such wise that the outer side of the cell will terminate in a point; and, finally, if at this moment the hypodermis is actively secreting cuticle, this pointed apex will be fixed as a central cuticular projection, which is the scale.

In the case of the *Miltogramma* larva, the outline of the cell is also polygonal; but although the outer surface of the cell is plane, the inner surface, as we shall show, is the special form of the surface of minimal area termed an *unduloid*. The morphogenetic problem we have here to deal with is therefore that of the effect produced on the plane outer surface of a cell polygonal in outline and whose inner surface is an unduloid, by a simultaneous antero-posterior and lateral pressure. This problem is perhaps capable of solution; though in order to account for the formation of a continuous ridge instead of a single central point, as in cells of the *Sarcophaga* larva, it might be necessary to consider factors which have escaped us up to the present. In any case this question is one which only an expert mathematician can handle.

This brief study of the causes of scale production in Muscid larvae does no more than touch the outer fringe of the subject. In order to complete it we should have to extend our investigations to a great number of forms. We should have to consider the distribution of the scales on the pseudopodia and the relations existing between the arrangement of the groups and the main lines of muscular traction; we should have to take into account not only certain more complex cases to which our hypothesis would probably apply,* but also a certain number of others in which the development of the cuticular scales appears to depend upon factors quite different from those hitherto considered.† We should have to study the scales in the initial stages of their formation and examine their transformations throughout the whole of the life-cycle—more especially at the moment of the moult.

(iii) *The insertions of the integumental muscles.*

If one examines a section of the larval integument at the point of insertion of an integumental muscle fibre, one finds that from the external surface of the end of the fibre there arises a group of very fine lines which converge across the hypodermal cell and the secondary cuticula and terminate in the primary cuticle. These delicate lines are the tonofibrillae, which have been described and figured by a great number of students of Arthropod anatomy.

The development of tonofibrillae appears to depend to some degree on the muscular power of the larva. For example, in *Miltogramma punctatum* the sheaf of tonofibrillae is represented only by a trapezoidal area more strongly coloured than the remainder of the secondary cuticula, and in which it is scarcely possible to distinguish the individual strands. In Calliphora, according

* One such case is that of the second-stage larva of *Digonochaeta setipennis*, Fall. Here (see Thompson, 1928, p. 129) the cephalic border of the anterior segments bear very few spines, but broad bands of anteriorly directed elements occur on the posterior margins of the segments. The arrangement of the spines on the anterior part of the body is thus the exact contrary of that which occurs in most larvae. However, in *Digonochaeta setipennis*, the form and cuticular armature of the body (as can be seen from the figure of the first-stage larva (Thompson, 1928, *l.c.*, Pl. IV, fig. 5)) is such that during contraction it is the posterior border of the segments that is inflexed and not the anterior border, in the anterior part of the body. An armature of stout cuticular thickenings, extending forward practically to the intersegmental conjunctiva, prevents the inflexion of the cephalic borders of the segments. The arrangement of the spines is thus perfectly explicable on the hypothesis outlined above.

† For example, in the first-stage Echinomyiine larvae (Thompson, *Ann. des Epiphyties*, t. IX, 1923), the bands of the spines are arranged exactly as in the species here studied, but in addition there exist scales or pigmented cuticular areas on regions where no muscular traction appears to be exerted. The formation of these structures seems to depend solely upon certain specific properties of the hypodermal cell, which the simple and primitive methods adopted in this essay are quite inadequate to investigate.

to the figure given by Ch. Perez (*l.c.*), the contrast between the group of tonofibrils, which are here very well developed, and the remainder of the hypodermis, is much more marked than in *Miltogramma*, and in the larva of *Melanochelia riparia*, Fall. (figured by D. Keilin * in his fine paper on the carnivorous Anthomyiids), which possesses an extraordinary powerful muscular system, the groups of tonofibrils are remarkably well developed and are actually prolonged into the interior of the body for some distance beyond the level of the basement membrane.

The development of the tonofibrils is generally admitted to serve the purpose of strengthening the integument at the point of attachment of the muscle fibre. Considered from another angle, the phenomenon of their production constitutes an interesting case of the adaptive reaction of the living substance, in which muscular traction produces precisely the effect necessary to prevent

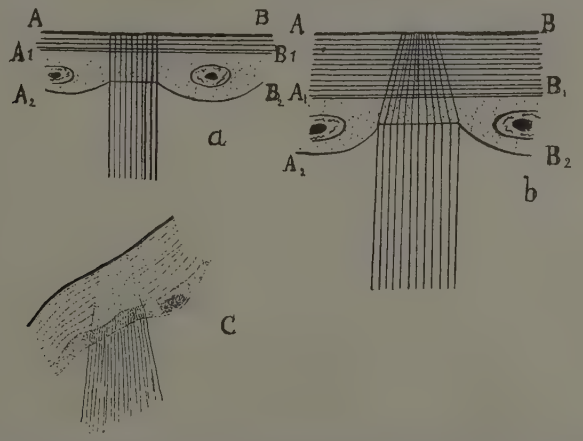

FIG. 18.—Muscular insertions : (*a*) at the beginning of a larval instar; (*b*) toward the end of the instar (both diagrammatic); (*c*) insertion of integumental muscle in Stage III larva of *Miltogramma punctatum* for comparison with (*b*).

the occurrence of any injurious results—such as the detachment of the hypodermis from the epithelium—due to this very traction itself.

The efficient causes of the form of the groups of tonofibrils have been briefly indicated by D. Keilin, in the paper just cited. " Quant à la structure fibrillaire de son contenu, ainsi qu'a l'orientation speciale de ses fibres, qui vont en faiseau convergent vers la couche exterieure de la chitine," he writes, " on ne peut invoquer d'autres facteurs que la traction d'une multitude de fibrilles musculaires exercée sur cette cellule hypodermique pendant toute la periode de son activité physiologique sécretrice."

Since the muscular traction is constantly exerted, by reason of muscular tonus, the formation of the tonofibrils must begin in the freshly formed cuticle and continue during the whole stage considered. At the beginning of the stage we shall thus have a condition like that represented by Fig. 18*a*, where the tonofibrillae follow exactly the line of the muscle fibres. But, during the following period, the volume of the larva increases because of the growth of all its tissues, including muscle fibres and hypodermal cells. The hypodermis

* 1917. *Parasitology*, **9**: 325–450, 10 pls.

continues to deposit new layers of secondary cuticula, while the layers already deposited increase in area, like the surface of an expanding rubber balloon. We shall thus have a growth in length of the lines AB and A_1B_1 in Fig. 18. However, the part of the cuticula in which the muscular traction has already been exerted, being more rigid than the rest by reason of the presence of tonofibrils, will be less affected by the growth of the body. Its superficial area, if it increases at all, will do so less rapidly than that of the remainder of the cuticle; and, finally, the older layers containing tonofibrillae will increase in area less rapidly than those freshly secreted, the former being of course harder than the latter. We shall thus ultimately get a series of superimposed layers or zones of cuticle containing tonofibrils, which increase progressively in area as we pass from the primary cuticle to the end of the muscle. In short, we shall have the condition shown in Fig. 18*b* and *c*. The greater the muscular traction, other things being equal, the greater will be the reaction of the hypodermis, and, consequently, the greater the resistance to local traction of the zones containing tonofibrils; and, finally, the more closely the sheaf of tonofibrils will approximate to a triangular form.

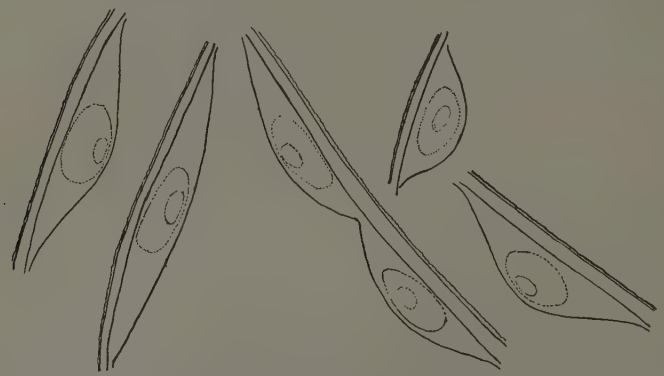

Fig. 19.—Various forms of the hypodermal cells of *Miltogramma punctatum*, in section.

(*d*) *The Form of the Hypodermal Cells.*

In the larvae of certain species of Muscids, such as *Sarcophaga falculata*, for example, the hypodermal cells do not greatly differ from those of Lepidopterous larvae; they form a layer of pavement epithelium whose internal surface is plane. But in other species, such as *Miltogramma punctatum*, *Calliphora erythrocephala*, and *Blepharidopsis nemea*, the majority of the hypodermal cells have a very different form, of which the sketches in Fig. 19 will give a general idea.

In his paper on the metamorphosis of the Muscidae, Ch. Perez has described and figured these cells for the *Calliphora* larva, and he compares them habitually to large hanging drops.

Now this description of the form of the hypodermal cell does not merely correspond to a superficial resemblance between the epithelial element and the hanging drop; it indicates in our opinion a real identity in the mathematical form exhibited in these two cases.

If we make a cardboard ellipse and roll it along the edge of a ruler, marking

on a sheet of paper the trajectory of one of the foci of the ellipse, we shall obtain a certain regular curve, which belongs to the mathematical family of the roulettes of the conic sections. As might be expected, this curve can be constructed by purely geometrical methods, though the mathematical reasoning involved is somewhat difficult. But fortunately the simple mechanical procedure mentioned above gives results sufficiently accurate for our purposes. We have only to vary the relation between the two axes of our cardboard ellipse in order to obtain a series of different forms of the curve we are studying.

If we now compare the form of one of these curves with the curve formed by the inner outline of the hypodermal cell in the *Miltogramma* larva, we shall find that these two curves are exactly the same. If we add to our drawing of the roulette of the ellipse a straight line to represent the basal membrane and a circle to represent the nucleus, we shall obtain a figure indistinguishable from that of an actual hypodermal cell. If the curve has been constructed with an ellipse whose axes are about equal, its form will resemble that of the more depressed hypodermal elements. If the axes of the ellipse differed greatly in length, the curve will be that of the inner border of the very convex cells.

Again, if one of these curves turns about an axis perpendicular to the line on which the ellipse rolls, and passing through the summit of the roulette, a surface will be generated which is exactly comparable to that of the hypodermal cell, provided the forces about the periphery of the latter are equal at all points. This surface is one called by the mathematicians an unduloid.

Now the unduloid (*v.* D'Arcy Thompson, *l.c.*, Ch. V) is one of a small group of surfaces of a quite special kind; to wit, the surfaces of minimal area, that is to say, the surfaces which present the smallest possible area for a given volume. As a matter of fact, the only surface of minimal area in the strict sense of the term, is that of the sphere. The unduloid is merely the approximation to the perfect type obtained in the presence of certain mechanical constraints—these being provided in the case of the hypodermal cell by the chitinous layer on the outside of the body of the larva and by the pressure of the adjacent hypodermal cells.

The special character of the surface of the minimal area is that it is a surface of equilibrium, that is to say, one in which the surface energy is a minimum for a given volume, so that the potential energy of the whole system tends to a minimum. The knowledge of these facts permits us to link up the determination of the form of the Muscid hypodermal cells with a vast group of facts and laws, extending far beyond the limits of biological morphology. All forms of capillarity, according to the physicists, may be explained as examples of the general principle that the potential energy of a system of bodies in rest tends to become the least possible. Thus the formation of a surface of minimal area in the hypodermal cell is simply a special case of the action of forces which determine the forms of liquid and semi-liquid drops.

(*e*) *The Tracheal System.*

(i) *The spiral thickening of the trachea.*

In Muscid larvae, as in other insects, the anatomically internal lining of the trachea consists of a chitinous layer which presents what is usually termed a "spiral thickening," but whose form is really that of a helicoid. This modification of the tracheal wall is usually considered simply with respect to its functional utility, which is supposed to be that of strengthening the tracheal wall and thus preventing it from collapsing, without diminishing its flexibility—like a coiled

spring within a rubber tube. But the morphogenesis of the tracheal thickening is also of interest. The tracheal epithelium consists of a layer of flattened and usually polygonal cells, that is to say, it consists of a number of more or less independent units. Now we can easily understand that from the combined secretory activity of these cellular units a continuous cellular layer may result, because the chitin is secreted in a liquid condition and naturally tends to form a continuous and homogeneous layer. But if, as the defenders of the cell-theory maintain, the activity of the organism is merely the resultant of the individual activities of a number of elementary organisms or plastids, then we have to explain just how it is that the cells of the tracheal epithelium can co-operate unconsciously so as to form a helicoid thickening continuous from one end of the trachea to another, especially since each cell produces not merely one section of the continuous filament, but several parallel sections of unequal length.

But this—like many inquiries to which the cell-theory has given rise—we take to be a mere pseudo-problem. In reality, we have no reason to believe that in the formation of the tracheal lining the epithelial cells act as independent entities. Since the tracheal filament is continuous, the natural supposition is that it results from the operation of some simple physical laws and is produced by forces which are unaffected by the existence of the cell boundaries in the tracheal epithelium, and act simply in the chitinous lining at the moment when it is being secreted.

The production of helicoid thickening or thinning in the wall of a tube is a phenomenon which may not necessarily arise always in the same way. For example, as D'Arcy Thompson points out (*l.c.*), a similar phenomenon is often witnessed in the splitting of a glass tube. " If a crack appears in a thin tube," says this author, " it has a tendency to be prolonged in its own direction, and the more perfectly homogeneous and isotropic be the glass, the more evenly will the split tend to follow the straight course in which it began. As a result, the crack in our test-tube is often seen to continue till the tube is split into a continuous spiral ribbon." But the formation of the tracheal taenidia is probably a more complex process. We have attempted to formulate a provisional explanation based upon the study of a certain type of tracheal filament which is in fact exceptional, but which nevertheless perhaps gives us the clue to a partial understanding of the structure with which we are dealing.

In the tracheoles, or fine terminal branches of the tracheae, the spiral thickening usually does not exist, the lining of the tracheole being in most insects a chitinous layer of uniform thickness. But in a certain number of Tachinid larvae, such as that of *Sturmia scutellata*, R.D., the lining of the tracheoles, like that of the finer tracheae, presents a special modification, which was first described by J. Pantel * and compared by him to a " collier de perles."

In these larvae, the lining of the tracheoles, instead of being a simple cylindrical layer of chitin, is moniliform, as the comparison of Pantel indicates, so that the tracheole closely resembles a chain of the conidia of certain fungi, such as *Monilia fructigena* (Underwood, 1899, *Moulds, Mildews and Mushrooms*, Pl. V, fig. 9). If one examines a number of tracheae and tracheoles, one finds that the form is not everywhere identical. The individual segments of the lining of the tracheoles are in some cases almost spherical; in others they are ellipsoidal in form; at times the constrictions between the segments are very slight. At the point where the group of tracheoles is attached to the tracheae

* 1901. *Bull. Soc. Ent. France*, **1901**: 51–61, figs.

from which they arise, the segments of the tracheolar lining are short, having the form of flattened spheres; as one proceeds towards the distal end of the tracheole, the segments assume first the spherical and then the ellipsoidal form, the constrictions between the segments becoming less and less marked. As one passes from the tracheoles to the finer tracheae from which the former originate, the diameter of the vessel suddenly increases, and at the same time, the length of the segments of the tracheal lining abruptly decreases so that the intima is now formed of a series of rings. Many of the smaller tracheae thus present annular thickenings, but in others we find not separate rings but a continuous helicoid thickening; and the larger vessels seem to show almost always not the annular, but the helicoid taenidia, which is indeed, as we have said, the usual form of the tracheal lining in insects (Fig. 20*a–e*).

In the smaller tracheae, the notches or intervals between the rings (which do not really line the intima, as the text-books usually assume, but run around the anatomically outer wall of the tracheal cuticula, being in fact adjacent to

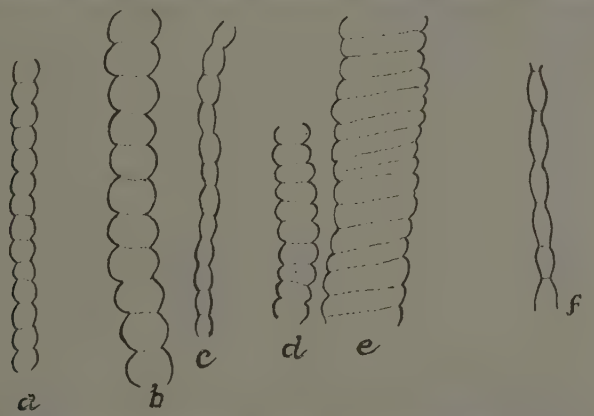

Fig. 20.—(*a–e*) Tracheoles and small tracheae of *Sturmia scutellata*, R.-D.; (*f*) jet of water breaking up into drops (the last after Edser "General Physics").

the epithelium itself) are clearly visible and open externally; but in the larger vessels these notches tend to close up externally; and in the great tracheal trunks they are completely closed so that when we examine the intima we simply see in optical section a series of oval spaces in the thickness of the tracheal cuticula.

Now the form of the chitinous lining of the tracheoles here described is almost exactly that which is exhibited by columns of liquid under certain conditions; for example, by a jet of water flowing from a tap. When the tap is wide open, the jet is in the form of a cylindrical column. But as the tap is closed, so that the diameter of the jet is reduced, it begins at a short distance from the opening of the tap to break up into a series of drops. If one took an instantaneous photograph of such a jet, it would have the appearance shown in Fig. 20*f*. This phenomenon of the breaking up of the jet, first into a series of segments separated by constrictions and finally into a series of independent droplets is a general characteristic of liquid columns, and it depends simply on the fact that a cylindrical surface whose length is greater than its circumference is unstable. In the jet of water falling from the tap, as we have already

mentioned, there obviously exists a definite relation between the diameter of the liquid column and the tendency to break up into segments or drops; and this relation seems comparable to that which we have noted as existing between the diameter of the tracheal vessels and the form of the segments of the intima.

At the moment of the formation of the chitinous lining of the tracheal vessels these latter are not filled with air but with liquid, and at the moment of its production the tracheal cuticula is also in a fluid condition. At this moment, therefore, the physical conditions in the tracheae and tracheoles are exactly those with which we have to deal with in ordinary liquid columns. As we have seen, the annular thickenings are not, as we are ordinarily told, on the *inner* lining of the tracheal cuticula, but on its (anatomically) *outer* lining, at least in the species with which we are now dealing; so that the production of the taenidia is not so much a thickening as a segmentation.

We therefore suspect that the formation of the tracheal thickenings is simply due to the operation of the physical forces which determine the segmentation of liquid columns. But it is evident that our explanation is little more than a statement of the problem. As we have said, the form of the tracheal segments changes in a definite and special manner as the size of the tracheal vessel increases, being in the finest vessels elongate ellipsoids, and in the largest vessels short rings. The change in form thus must have some regular relation to the diameter of the tracheal vessel, and seems to show that there here operates some simple physical law. But this is as far as we can go at present. Furthermore, at a certain point in the tracheal vessel, the annular thickenings become irregular and finally join up in such a way as to produce a continuous helicoid filament. This may be due to the fact that the forces and stresses acting about the great tracheal trunks, which run along the sides of the body, are asymmetrical; but in precisely what way this asymmetry in the forces acting about the vessel could produce the change from the annular to the helicoidal taenidia, we cannot say.

All that seems clear is that there can probably be found, in the simple physical properties of liquid cylindrical surfaces, operating under the special conditions present in the tracheal vessels at the moment of the secretion of the chitinous lining, the efficient causes of the production of the spiral or annular thickening in its various forms.

We cannot say, of course, why the curious beaded tracheoles found in the *Sturmia* larvae are not more frequently met with. But we have noted that in some of the species possessing tracheoles of this type the chitinous intima of the respiratory vessels presents a very unusual reaction to certain stains. In preparations stained with iron haemotoxylin the tracheal and tracheolar lining takes up the colouring matter with extraordinary intensity, so that these vessels remain deeply coloured long after the stain has been washed out by the mordant from all of the other tissues of the body. On the contrary, in the other Tachinid larvae we have examined, where the lining of the respiratory vessels is of the usual type, the tracheal intima shows no special affinity for this stain.

(ii) *The posterior spiracles.*

(*a*) In the first-stage larva of a species like *Miltogramma punctatum*, the spiracular slits of the posterior stigmata, which constitute in this instar the only respiratory openings, are situated in the case of each spiracle in the middle of a rounded chitinous area which we may call the stigmatic plate. In stages II and III, the group of spiracular slits continues to occupy this central position in the stigmatic plate, of which the boundaries are now more or less clearly

defined by a chitinous ring called the peritreme. At the end of each stage in its development the larva moults. In this process the tracheal intima is shed, at least in part, at the same time as the cuticula; and in the stigmatic plate of the second- and third-stage larvae the trace of this process remains in a minute dimple or scar, which of course marks the exact point at which the spiracle opened in the preceding stage. Although the stigmatic slits as a group occupy the central region of each stigmatic area, the moulting scar just mentioned is in most cases strongly excentric, being situated at a point near the border of the stigmatic plate (Fig. 21).

(*b*) If we compare one with another the felt-chambers of the posterior spiracles in the successive stages, we find that, as our figures (Fig. 22*a–c*) show, the increase in length of these regions is relatively feeble in comparison with their increase in diameter, so that whereas in the first stage the felt-chamber was long and slender, in the last stage it is short and broad.

(*c*) In general, as we have said, the stigmatic moult scar is situated near the border of the stigmatic area, and the stigmatic slits converge toward it like the radii of a circle toward its centre. Now if the outer extremities of the spiracular slits be joined and from the middle of the arc so obtained there be drawn a line passing through the moulting scar, we may use as a specific

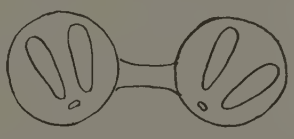

Fig. 21.—Second-stage spiracles of the larva of *Miltogramma punctatum* (semi-diagrammatic).

character the angle θ made by these two lines as shown in Fig. 23.* In some species this angle approaches 90°; in others it is an angle of about 180°, and in some forms, if the figures given are to be relied upon, it may be as great as 220°. Between these extremes there may be found a whole series of intermediary forms, of which those interested may get some idea by consulting the works of Banks, Greene, Nielsen and Keilin on the larvae of the higher Diptera.

Now all these various types of spiracular arrangements appear to depend upon the operation of very simple factors.

It is evident that, from the uniform growth of the stigmatic area, provided that no factor comes into play to disturb the relations of the various parts, there should result in the second stage a spiracle whose moulting scar would occupy a central position. In the same way, the moulting scar representing the original position of the second-stage spiracle would be in the centre of the stigmatic area of the third-stage larva. Such a condition, though uncommon, is not unknown. The posterior stigmata of several species figured by Greene † in his fine paper on Tachinid puparia, such as *Tachinophyto tortricis*, Coq., and *Oestrophasia ochracea*, Bigot, show central moulting scars. But in the great majority of cases the moulting scar is not central, being situated near the border of the stigmatic field, and, to be more precise, near its inner margin.

The reason for this fact is, that not far from the anterior extremity of the felt-chambers, a short and stout transverse tracheal commissure unites the

* This has already been pointed out by Metcalfe.

† 1922. *Proc. U.S. Nat. Mus. Washington, D.C.*, **60**, Art. 10: 1–39, 20 pls.

two main tracheal trunks (Fig. 22). Before the moult takes place the tracheal epithelium separates from the chitinous lining, the diameter of the lumen of the trachea increases, and the tracheal epithelium begins to secrete a new intima. If the posterior region of the tracheal system is examined at this moment, the old felt-chambers and tracheae, still filled with gas, will be seen lying in the midst of a liquid filling the cavity of the trachea of the following stage.

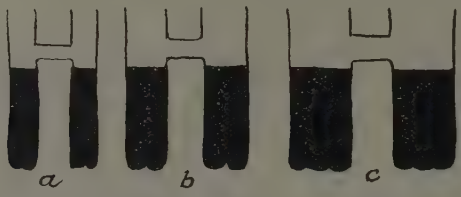

Fig. 22.—Felt-chambers in three successive stages.

Now, other things being equal, if the posterior tracheal commissure did not exist, the old felt-chambers would lie, as we have seen, along the longitudinal axes of the new felt-chambers. But since it exists, and unless it ruptures prematurely, the position of the new trachea cannot be symmetrical with respect to the old trachea. The increase in area of the posterior extremity naturally tends to increase the distance between the stigmata, and, consequently, between the felt-chambers. The posterior commissure prevents the distance between the old felt-chambers from increasing. Consequently the enlargement of the tracheal trunk in the stigmatic region can only occur freely in a radial direction, so that the inner side of the new felt-chamber comes to lie

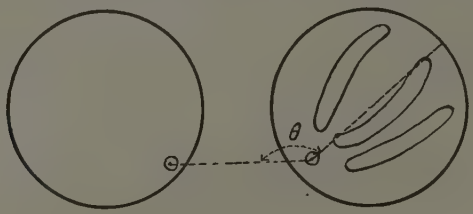

Fig. 23.

against the corresponding side of the detached felt-chamber of the preceding stage. We thus have the condition shown in Fig. 24. The new cuticular lining of the trachea then begins to solidify. At the moult, the cast-off posterior commissure breaks and the felt-chambers and tracheae issue through an opening near the internal border of the new spiracle. A good figure of this stage was given long ago by Weismann.*

Again, the existence of the posterior commissure has also the effect of preventing the distance between the posterior margin of the new transverse trunk and the posterior extremity from increasing to any marked extent. The part of the tracheal epithelium secreting the felt-chamber can thus increase in diameter, but not in length, unless, as is sometimes the case, the commissure

* 1864. *Die Entwicklung der Dipteren,* Leipzig, Pl. 8, fig. 6.

is in the first stage at some distance in front of the anterior extremity of the felt-chamber.

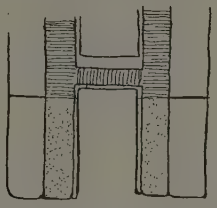

FIG. 24.—Formation of new tracheae around the moulted tracheae of the preceding stage.

In order to understand the factor on which depends the various positions of the spiracular slits observed in the various species, we may take first the simple case where the posterior surface of the larva is a circular plane surface. Call the centre of this area (Fig. 25) *C*, and let the position of the first-stage stigmata be indicated by the points P_1 and P_2. The line $P_1 P_2$ will thus correspond to the commissure. The figures *a*, *b* and *c* may then represent the posterior extremities of three different species. In the first the spiracles lie along the line of the horizontal diameter $D_1 D_2$ of the posterior extremity; in the second, above the diameter, and in the third, below it.

Now, as the larva increases in size, the surface of the posterior extremity increases in area. The points P_1 and P_2 thus tend to migrate along the line $D_1 D_2$ in the case *a*, or along the radii CP_1 CP_2 in cases *b* and *c*.

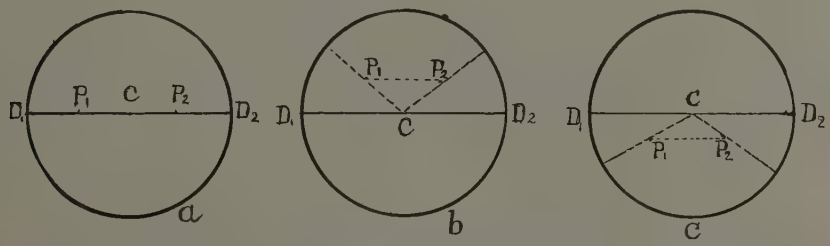

FIG. 25.—*c*, centre of the posterior extremity; D_1D_2, diameter; P_1P_2, situation of the posterior spiracles; the line P_1P_2 is the line of the posterior tracheal commissure.

Suppose that in the preceding stage the position of the spiracular openings is that indicated in Fig. 21. At the moment of the moult, the stigmatic plates increasing in size move, as we have said, along the radii CP_1 and CP_2 until such time as their progress is arrested by the cast-off felt-chambers, bound together by the cast-off but still unbroken commissure, and will thus finally occupy in relation to the spiracles of the preceding stage the position shown in Fig. 26*a*; and the stigmatic slits, which always tend to arrange themselves symmetrically in relation to the moulting-scar, will assume the position shown.

Such is as a matter of fact the condition of affairs in many larvae, as for example in *Muscina assimilis*, Fall., and *Phorbia floccosa*, Meig., according to the figures given by Banks * and in the larvae of the Tachinids, *Compsilura concinnata*, Meig., and *Dexodes nigripes*, Fall.

* 1912. U.S. Dept. Agric. *Bur. Ent.*, Tech. Ser. 22, Pl. II, fig. 21, and Pl. VI, fig. 109.

When the points P_1 and P_2 occupy the positions shown in *b* and *c*, Fig. 25, an increase in area will carry each of these points, not along a line parallel to the diameter, but along the radii CP_1 and CP_2 produced. The new stigmatic plates will then assume in relation to those of the preceding stage, the position

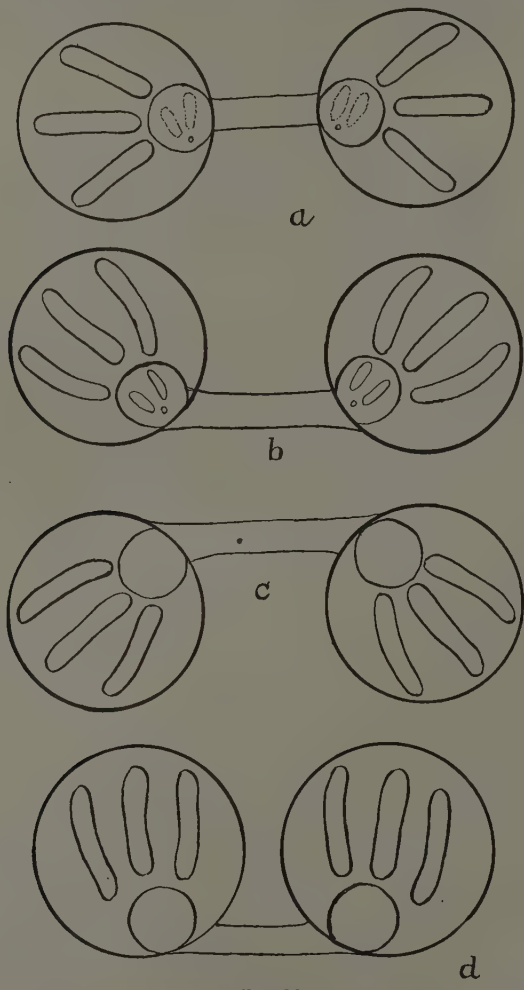

Fig. 26.

in Fig. 26*b* for the case *b* and in Fig. 26*c* for the case *c*. The position *b* is approximately that shown by the spiracular slits of *Tachina larvarum*, L., of *Tricholyga grandis*, Zett., and of *Protocalliphora chrysorrhoea* (Banks, *l.c.*, Pl. III, fig. 59), while the position *c* is characteristic of the Muscid *D*, figured by Banks (*l.c.* Pl. II, fig. 34), and of *Panzeria penitalis*, Coq., according to Greene (*l.c.*, fig. 41).

Again, since the stigmatic slits tend to arrange themselves symmetrically in relation to the common diameter of the great and small circles of our diagrams, we can readily show that the special position occupied by the slits, in any specific case, depends especially on the angle $P_1 CD_1$ or $P_2 CD_2$ (Fig. 25). The more closely this angle approximates to 0°, the more nearly the position of the slits will approach to that of our diagram 26*a*; on the contrary, as this angle approaches 90°, the slits will take the position like that of 26*b* and finally like that of 26*d*, this latter being approximately that characteristic of the figure given by Banks of an unknown Sarcophagid (*op. cit.*, Pl. IV, fig. 72) and that of *Tachina robusta*, Twns., as figured by Greene (*op. cit.*, Pl. 17, fig. 79). Unless factors other than those hitherto considered intervene, such a position can only result if the stigmata are very close together and the distance CP is considerable.

When the points P_1 P_2 lie below the diameter D_1 D_2, one could have, at least theoretically, all the series of arrangements which exist in the cases where these points lie above the diameter; but in these cases the slits would be directed downward instead of upward. In reality the instances in which the spiracular slits are so arranged are rare, no doubt because the ventral region of the posterior extremity is occupied by the rectum and the anus.

In many larvae, instead of the three slits we have represented there is a greater number; in others, the slits are not straight but curved or undulating. But even in these cases the arrangement of the openings is quite comparable to what has been described, and probably depends on the same factors.

Finally, the surface of the posterior extremity of these larvae is not by any means invariably a plane surface; it is sometimes convex and sometimes concave, as in the majority of the SARCOPHAGIDAE. In such cases, as is fairly obvious, for a migration along the radii C_1 P_2 and C_2 P_2 the straight-line distance between the spiracles will increase less than in the case of a plane surface; and the greater the convexity or the concavity, the less the spiracles will tend to separate the one from the other for a given increase in the area of the posterior extremity. In such cases, therefore, if the points P_1 P_2 lie above the diameter D_1 D_2 we shall frequently have cases where the slits are arranged as in Fig. 26*d*. As we have noted, this arrangement characterises the larva of *Sarcophaga* described by Banks, and as a matter of fact we have often observed it in other larvae of this genus, such as *S. falculata*, Pandellé.

Thus the various arrangements of the spiracular slits in Muscid larvae, in spite of their variety and specific constancy, seem to depend upon very simple factors: the initial position of the stigmatic slits, the form of the posterior extremity, the presence of the posterior tracheal commissure, and the increase in area of the posterior extremity.

(*f*) *The Sense Organs.*

The organ called the antenna in Muscid larvae is a small structure situated on the dorsal pleural aspect of the cephalic segment, and consists of a convex terminal portion having in many species, especially in the initial stage, the form of an ellipsoid of revolution and a short basal ring-shaped portion. During the life-history of the larva, this organ gradually changes in form, its height diminishing in proportion to the area of the base. A glance at the figures of the antenna of *Miltogramma punctatum* in the three larval stages, will perhaps give a better idea of this transformation than could be obtained from a mere description (Fig. 27).

It is evident that the efficient causes of the change in the antennal form

cannot be excessively complicated. The structure of the organ is very simple, since it consists merely of a transparent chitinous capsule filled with an albuminous fluid beneath which is the bulb of mixed hypodermal and nervous origin, corresponding to the trichogenous cell of an ordinary sensory hair. Since we find no trace of any complicated mechanism on which the change in antennal form might depend, we are justified in attempting to explain it as due to the action of relatively simple physical forces.

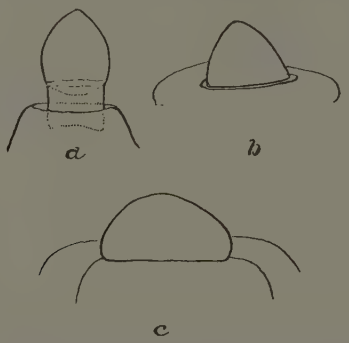

Fig. 27.—Form of the antenna of *Miltogramma punctatum* in the three larval stages; (*a*) Stage I; (*b*) Stage II; (*c*) Stage III.

Let AB (Fig. 28) be the projection of the surface S_1 of the epithelial area which secretes the antenna in the first stage; let ACB be the projection of the surface of the organ of volume V_1 and which we will suppose for the moment to be a hemi-spherical surface. Let OA be the radius of the secreting surface.

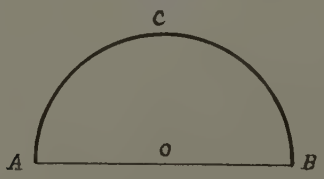

Fig. 28.

Put OA 3 Units of length.

Therefore $S_1 = \pi r^2 = 28{\cdot}3u^2$ . . . . . (1)

also $V_1 = \frac{1}{2}(\frac{4}{3}\pi r)^3 = 56{\cdot}6u^3$ . . . . . (2)

Suppose now the volume of the antennal cavity depends on the area of the secreting surface, and not on the volume of the cells which compose it, and let the radius of this surface increase from $3u = r_1$ in stage I to $5u = r_2$ in stage II.

Therefore $S_2 = 78{\cdot}4u^2$ . . . . . (3)

Let us suppose, according to the hypothesis, that the secretory value of each unit of surface remains constant; this value is thus from (1) and (2) :—

$$\frac{56{\cdot}6}{28{\cdot}3} = 2u^3 \text{ for each } u^2 \text{ of surface.}$$

The volume of the antenna will now be,

$$V_2 = 156{\cdot}8u^3.$$

Suppose now that this volume arranges itself on the surface in such a way as to present itself a surface of minimal area, assuming the form of a segment of a sphere. In order to determine its exact form, we have the following data :—

$$V_2 = 156{\cdot}8u^3$$
$$r_2 = 5.$$

The formula for the volume of a segment of a sphere is

$$V = \frac{\pi h}{6}(3r^2 \div h^2)$$

from which

$$156{\cdot}8 = \frac{\pi h}{6}(75 \div h^2)$$

or

$$h = 3{\cdot}4 \text{ approximately.}$$

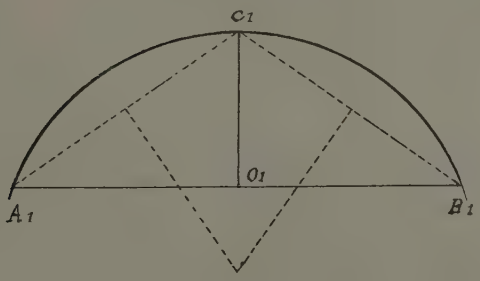

Fig. 29.

Now, since we wish to make only a figure of the antenna, we have only (Fig. 29) to consider the area of ACB of which we know the chord AB and the three points on the circumference, A, C and B. A simple mechanical construction will give us the centre of the circle passing through these two points. The area ACB is now the projection of the surface of the antenna in the hypothetical second stage. If we compare the diagrams with the figures of the antenna in *Miltogramma punctatum* in stages II and III, we find that the modification in form is in both cases of the same general type. We have thus reproduced what seems to be essential in the transformation of the organ. If we take as our point of departure, not a hemisphere, but an apical segment of an ellipsoid of revolution, we can get a still closer approximation to the reality. In this case, to avoid entering into any mathematical calculations, we may assume that, as in the case of the sphere, the change in form is simply that obtained by moving the base AB (Fig. 30) up toward the summit C, so that it takes successively the positions $A_1 B_1$ and $A_2 B_2$. If the regions $A_1 CB_1$ and $A_2 CB_2$ were then drawn separately in such a way that the area of the base of the antenna is equal to the magnified area of the real organ in the successive stages, we should obtain a series of figures practically identical with those of the *Miltogramma* antenna.

In many larvae, the antenna in the first stage is not an ellipsoid of revolution of the type shown, nor even a hemisphere, but resembles in form that of the *Miltogramma* larva in stage III, this form being especially characteristic of parasitic larvae deposited in or on the body of the host, as in opposition to those which are free-living in the initial part of the first stage. In this case, the transformation of the antenna proceeds along essentially the same lines; but in the later stages the convexity of the antenna is so slight that the difference between stage II and III is very difficult to measure.

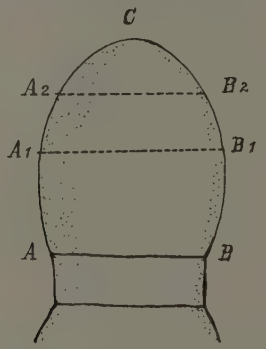

Fig. 30.

In other larvae, although the change in form as between stage II and stage III corresponds with what we have described, a much greater difference exists between the first and second stages. For example, the antennae of the first-stage larvae of *Digonochaeta setipennis*, Fall. (Thompson, 1928, *l.c.*), of *Melanophora roralis*, L., and of *Cyrillia angustifrons*, Rond. (Thompson, 1917 and 1920)* are extremely long and slender, terminating either in a point or in a long flexible filament; while in stage II this organ is of the usual type, being bell-shaped in form. In this case the form of the antenna is similar to that of an ordinary hair such as occur in adult Muscids or on Lepidopterous larvae, but the exact mechanism of its production is not yet known.

III. The Significance of the Physico-mathematical Explanation in Biology.

1.

In the first part of this paper we have endeavoured to show, by the study of the examples taken in a single systematic group, that organic form may be considered as determined by the operation of various mechanical, physical or chemical forces, which are often of a very simple kind, although they may combine and interact in a very complex way. The cases we have examined have necessarily been very simple ones. We have been able to show, for example, how the combined action of a few physical forces may determine the characteristic form of the Muscid puparium, but we are not able to suggest any explanation of this order for the form of the pupa, or, *a fortiori*, of the adult.

* 1917. *C. R. Soc. Biol., Paris*, **80**: 785–788, figs. 1920. *C. R. Acad. Sci. Paris*, **170**: 1621.

We are thus naturally led to ask ourselves whether in these latter instances such an explanation could be conceivably found; or whether, on the contrary, the methods employed are in reality inapplicable to the more complex problems of organic morphology.

On the other hand, granted that it is at all events theoretically possible to find a physico-mathematical explanation for the more complex types of organic form, the question as to the ultimate significance of this explanation still remains matter for discussion. For example, granted that by physico-mathematical methods it would be possible to formulate an exact and detailed explanation of the form of the adult Muscid, in what sense can this explanation be considered as complete? In solving this problem, have we solved the problem of life, or does our analysis of the causes involved, no matter how accurate or detailed it may be in its own special order, leave untouched some groundwork or residue upon which the methods employed take no hold?

Our inquiry thus resolves itself into an investigation of the ultimate meaning or import of the physico-mathematical explanation in biology.

Now it is immediately evident, that if our methods are really inapplicable to the more difficult problems of organic morphology, then they are nowhere applicable, even in the most simple cases; and if by their use we seem at times to discover apt and plausible explanations of the form of living things, then either these explanations are of merely illusory value, or else they apply only to objects or materials which are no longer properly living or have not yet entered into an intimate union with the organic being itself.

Such is the opinion of certain philosophers of the vitalistic school. "Dans la domaine de la vie," says M. Bergson,* "... le calcul a prise, tout au plus, sur certains phenomènes de destruction organique. De la creation organique au contraire, des phenomènes évolutifs qui constituent proprement la vie, nous n'entrevoyons même pas comment nous pourrions les soumettre à un traitment mathématique."

The opinion of the mechanistic philosophers is in general the exact opposite of the one just cited. Biologists like Bütschli, Herrara, Leduc and Rhumbler, having succeeded in imitating by physico-chemical methods many forms, structures and processes undoubtedly characteristic of living organisms, have not hesitated to put forward the results of their experiments as solutions of the problem of life itself. "I have been able to realise, by means of physical forces," wrote Leduc,† "the phenomena of nutrition, organisation and growth. These three functions considered up till now as essential manifestations of life, have been realised by means of physical forces. The growth of artificial plants is easily affected by all physical and chemical excitations. These plants repair their wounds. If they are broken, once their growth is under way, the fragments rearrange themselves and fuse, and growth recommences. A single function remains to be realised, in order to complete the synthesis of life: reproduction in series, but I hold that this problem is of the same nature as that which I have already solved."

By methods similar to those employed by Leduc, Herrara ‡ believed that he had reproduced all the phenomena which occur in living cells. "The experiments undertaken by Herrara," wrote Renaudet,§ "show that silicates can live, indeed must live, if we reflect upon the extraordinary polymorphism which they present."

* 1914. *L'Évolution Créatrice.* Paris. Edit. 18, p. 21.
† Cited by Gemelli, *L'Enigma della vita*, Florence, 1914.
‡ Cited by Gemelli, *l.c.* § Cited by Gemelli, *l.c.*

"The possibility of understanding vital phenomena by physico-chemical mechanisms will be contested," said Bütschli in 1901, "as long as mechanical solutions have not been found for all of their details. . . . At present, therefore, we simply have to show, that the vitalistic objections against the efficacity of mechanism for arriving at a sufficient comprehension of life, do not constitute a proof of such an impossibility"—from which we may conclude that in the opinion of Bütschli, the vitalistic objections against the mechanistic doctrine, as a complete explanation, not simply of material arrangements in living beings, but of life itself, are invalid.

However, the methods employed and the conclusions drawn by many of the writers we have named have not always met with approval, even from biologists opposed to the vitalistic doctrines. "Quelques esprits simplistes," writes the Lamarckian mechanist M. E. Rabaud,* "ont cru possible de les éluder (experimental difficulties) et d'étudier les organisms vivants, en créant de toutes pièces leur matériel expérimental. Le premier en date de ces essais a pour auteur Bütschli, qui se proposait de mettre en évidence la structure du sarcode, trop rebelle à l'analyse directe. En melangeant ensemble diverses substances, dont deux au moins ne se trouvent pas dans la sarcode, de l'huile d'olive, du sucre et du sel de cuisine, Bütschli obtint un produit qui, examiné au microscope, donne l'impression di sarcode alvéolaire animé de mouvements. D'autres auteurs ont également prétendu donner des explications 'expérimentales' de même ordre pour la division des noyaux des cellules, pour diverses phases embryonnaires. Henking, laissant tomber une goutte d'eau ou d'alcohol sur une lame de verre noircie au noir de fumée, montre des images semblables à celles de la caryocinèse. Zeigler, Gallardo, les obtiennent en mettant en oeuvre les influences électrique sur de la limaille de fer ou sur les cristaux de sulfate de quinine en suspension dans un mauvais liquide conducteur. Et Rhumbler donne une 'explication' de l'invagination gastrulaire en construisant des modèles de blastules dans lesquels les cellules sont des anneaux d'acier. Tout près de nous, Leduc a cru decouvrir le secret des phénomènes vitaux les plus complexes, en plongeant dans une solution de gelatine des substances variées qui forment une membrane semi-perméable et donnent lieu à un courant osmotique intense. Ces substances se distendent, affectant des formes très diverses qui rappellent plus ou moins des formes vivantes; de ces ressemblances très vagues et toutes superficielles, Leduc tire la conclusion que l'osmose joue un rôle prépondérant dans la genèse des êtres. La vérité m'oblige à dire que des biologistes réputés prennent tous ces essais au sérieux. Est-il besoin, pourtant, d'insister pour montrer que ces imitations grossières, d'une naiveté sans égale, n'ont avec le but qu'ils poursuivent aucun rapport véritable. A ces imitations il manque l'essentiel qui est l'organisme lui-même; elles ne remplissent donc aucune des conditions que nous nous proposons d'étudier et correspondent moins aux expériences biologiques qu'un modèle en cire ne correspond à une pièce anatomique. Il faut le répéter, il faut s'en convaincre, et ne pas se laisser prendre à ces apparences vaines."

The opinion of M. Rabaud thus resembles to some extent that of M. Bergson; though in their general conception of biological phenomena these two authors almost completely disagree. M. Bergson denies that the physico-mathematical method may be applied to living form; to this opinion M. Rabaud would certainly be opposed, but on the other hand he appears to deny that from observations on the action of physical forces in the inorganic world we can arrive at any real comprehension of organic morphology.

* *Elements de Biologie Experimentale*, Paris, 1920.

A diversity of opinions in regard to the matter at issue is thus not lacking.

Since the application of physico-mathematical methods to biological problems becomes every day of greater importance, and since it offers, without doubt, an interesting field for research, it seems worth while to consider it rather carefully, especially since the majority of workers who utilise these methods have either made no attempt to determine their real significance and general value, or have expressed opinions on these points which are in many ways extremely unsatisfying.

2.

In order to make our treatment of the question intelligible, it is necessary to begin at a point somewhat remote from the question at issue.

Let us recall, to begin with, that science, which we may define with the medieval philosophers as the certain knowledge of things in their causes, is of two types, the *deductive* and the *inductive* or *experimental*.

The deductive sciences, of which mathematics is an example, have as their distinguishing feature the fact that they deal with something whose nature or essence is intelligible to us, so that by reflection upon its inherent necessities we can arrive at definite and certain conclusions regarding it. The deductions we make in these cases do not depend upon observation and experiment in any way. Given the definition of a Euclidean triangle, all the facts concerning its properties can be deduced without any recourse to measurement or experiment, whether such a thing as a triangle actually exists in nature or not. The mathematician has no troubles with apparatus which refuses to work or with organisms which refuse to reproduce. The problem of individual variation does not exist in mathematics. The mathematician moves in a world completely detached from the contingencies of existence as it really is.

The inductive sciences—sciences of observation and experiment—deal with things having not merely a logical, but a real existence, and of whose nature or essence we can have no direct knowledge and can define only partially and imperfectly through its manifestations. The whole object of sciences of this type is indeed the gradual and laborious accumulation of information concerning the way in which the nature of the thing studied manifests itself under various conditions. When we have demonstrated a constant connection, under certain given circumstances, between two or more aspects of a thing—for example, between a certain structure and a certain function in an organism—we have discovered what we call a law, which is an indication of some essential connection or internal necessity. But relations we thus establish are almost always relations existing only in certain circumstances. In other words, they are contingent relations, which hold good only under certain conditions. We cannot envisage them directly, as they are in themselves, and consequently cannot use them as a basis for deductions in regard to circumstances whose effect has not yet been experimentally determined. For example, no matter how long or how carefully we have studied an organism, we can never be quite sure what it will do in circumstances in which we have never observed it.

For this reason the inductive sciences, in spite of their variety and interest, cannot completely satisfy the human mind. They therefore tend to take on a deductive character and to resolve themselves either into philosophy or into mathematics.

The ultimate end of the process whereby the data of science are resolved into philosophy is in itself inaccessible to scientific research or verification. Not *things* but the *principles and reasons of things* are the object of philosophy. On

the other hand, explanations of the philosophical order can never replace explanations of the scientific order, though the philosopher can show when the scientist has philosophised (or reasoned) incorrectly. We cannot deduce from *philosophical* principles any certain conclusions in regard to the course of natural phenomena. The rationalisation of scientific data by the philosophical method is thus not in itself *useful*.

The ultimate end of the process whereby scientific data are resolved into mathematics is the establishment of a mathematical relation between quantitative values (numerical or dimensive) actually observed in Nature. The principles and causes of things are not considered. The only data which can be incorporated into the mathematical system are those of the purely quantitative order. It must, however, be noted that we can be more *certain* about this type of data than about any other data obtained through the avenues of the senses, since we are able to obtain it by the use of *instruments* by which the precision possible to human faculties is tremendously increased. Furthermore, in its point of contact with human affairs—at the point where it becomes *applied science*—quantitative values are of absolutely primary importance in science. It is thus not astonishing that, in the environment provided by modern civilisation, science tends more and more to develop along mathematical rather than along philosophical lines. Although we may deplore the neglect of philosophy there seems little prospect of its early revival. In all human probability the most important developments in biology for a long time to come are likely to be along physico-mathematical lines.

If we classify the natural sciences roughly into *Physics*, dealing with the properties common to bodies, *Chemistry*, dealing with the specific characteristics of different kinds of bodies, and *Biology* dealing in Botany with living bodies presenting the phenomenon of nutrition, growth and reproduction, in Zoology with living bodies characterised in addition by the ability to receive sense-impressions, and in Anthropology with man, characterised by the power of intelligence or reason (and irrespective of any opinion we may hold as to the absolute value of this classification), we note that reduction to mathematical form of the specific object of these sciences becomes increasingly difficult as we proceed.

One hope of attaining the mathematical ideal is thus that the objects of the higher sciences can be gradually resolved or decomposed into the objects of the lower, until the whole of the data available is boiled down into mathematical form. Human behaviour would thus be explained as a combination of instincts, imaginative processes and so on, animal behaviour as a combination of reflexes and tropisms, vegetative life as a complex of chemical reactions, chemical affinities in terms of physical forces, physics, via mechanics, being reduced to purely quantitative elements and absorbed by mathematics.

3.

Let us now consider more particularly the reduction of biological data to mathematics. This can be attempted directly or indirectly.

The direct method consists simply in the mathematical treatment of measurements or quantitative values obtained from the living being itself. The indirect method (or what commonly passes as such) consists in the mathematical treatment of quantitative data obtained from something not in itself living, but considered to be identical with it in respect to the form or process considered.

Investigators do not always distinguish between these two very different methods, and indeed (so general is the conviction that the objects of the various

sciences of nature differ merely in the degree of complexity) are often not at all prepared to admit that they are not dealing directly with biological questions, even though the material they handle is obviously non-living.

It is of course sometimes very difficult to decide on the dividing line between living and non-living forms and movements. Non-living materials are both taken up and given off by the organism; but it is very hard to determine exactly when these substances begin or cease to be part of the living being. Some structures of which the form can be mathematically treated—such as horns and shells—are perhaps themselves not alive, but their form is a consequence of the manner in which the growth of the living substance has proceeded. Furthermore, certain substances removed from the living body exhibit after their removal properties which seem, as far as one can tell, to be at least very similar to those they exhibited while still an integral part of the organism.

These difficulties, which are certainly great and perhaps insurmountable, need not, however, be considered here, as they have no direct bearing on the problem with which we are dealing.

Thus, however we are to define the frontier between the living and the non-living, it is at least quite certain that in the living being itself there are processes which fall properly within the fields of chemistry, physics and mathematics. The living body is chemically heterogeneous. Interactions of the chemical order occur between its different parts. It is a body, having, like all other bodies, certain general physical properties, which differ at different moments and in different parts. It has certain quantitative characteristics. The physical properties it presents—its weight, size, temperature and so forth—are qualities of which the intensity is measurable, or whose changes can, at least, often be correlated with measurable changes. For example, within certain limits the velocity of development of many organisms increases with an increase in temperature, in a way that can be expressed by a mathematical equation of a very simple type. Again, we can recognise in living bodies a great number of pure geometrical forms, such as the circle, the ellipse, the helicoid and the logarithmic spiral. Our recognition of these forms does not necessarily depend upon any considerations regarding the manner in which they arise; so that here, as in the first case mentioned, our mathematical representations have, so to speak, their roots in the living things themselves.

Provided there are *constant* and *regular* relations between the quantitative aspects of living bodies, and to the extent that these exist, a science of biomathematics is therefore possible. That such a science can be exhaustive in relation to vital phenomena, may be doubted; its intrinsic deficiency has indeed already been indicated. But that it can exist seems certain.

The attempt to subject biological phenomena to mathematical treatment by indirect methods constitutes a much more difficult problem. This method consists essentially in the reproduction of some form or process observed in the living being, in non-living material and in the explanation of the origin of the structure or phenomenon considered by properties observed in the non-living world and assumed to act in living bodies in the same way as they act in inanimate bodies. On the basis of certain resemblances it is decided that the same law, which may perhaps be expressed in mathematical form, is followed in both cases, after which deductions concerning the biological phenomena considered may be drawn from the mathematical expression. Thus the form of the cells in a segmenting Molluscan egg can be reproduced in an aggregate of soap-bubbles. The form of the curved surfaces and planes in the soap-bubble aggregate is due to the action of the laws of capillarity and can be mathematically

treated. The explanation and treatment of the inanimate system is considered to be applicable to the animate system because they are identical in respect of the phenomenon considered. Vast groups of tremendously complex and very different phenomena are sometimes linked up in this way as in the recent work of Lotka,* where " Physical Biology " is considered as a " branch of the greater discipline of the General Mechanics of Evolution, the mechanics of systems undergoing irreversible changes in the distribution of matter among the several components of such systems."

4.

The general type of argument used in all of the work of this kind is the same. In order to be quite clear as to the exact significance of the work, a careful examination of the argument utilised or implied in it is necessary.

The argument is, of course, an *argument by analogy*. Now the argument by analogy consists essentially in an imperfect or inadequate induction whereby a general principle is incompletely established, after which a conclusion concerning some particular case, not originally used as a basis for the induction, is then deduced from the general principle. The weakness of the reasoning arises from the fact that the data used in the first instance are really not sufficient to permit of the establishment of an absolutely general law, so that more is being extracted from the argument than was put into it. It is not certain that all the *species of phenomena* (i.e. *all the phenomena formally different in respect to their causes*) covered by the general law were included in the material used as a basis for the induction. If they were not, then the principle that has been established may not really be valid in relation to the particular phenomenon to which it is applied. It is easy to fall into the error of calling different phenomena or groups of phenomena by the same name, and thus affecting an illicit transferal of a law covering one set of facts to another set specifically distinct from it.

The significance of the argument from analogy is thus evident. The argument is not *worthless*, because a general principle has, at all events, been partially though incompletely established. It is not *conclusive*, because it is not certain that the principle, inductively established, actually covers the type of phenomenon it is desired to explain. It leads simply to a *probability*, the degree of which depends principally upon the likelihood that the data used as a basis for induction are sufficiently numerous and varied to lead to a law of really general value. It is obvious that this is a point in regard to which no fixed rules can be laid down, so that a variety of opinions is admissible in regard to any particular case.

It will now be clear that the drastic criticisms of the physico-mathematical method in biology, put forward by Professor Rabaud and quoted at the beginning of this section, are to some extent unjustified. " A ces imitations grossières," writes Professor Rabaud, " il manque l'essentiel, qui est l'organisme lui-même." But this is not an unanswerable argument. The object of the experiments referred to is simply the reproduction of a certain *form* observed in the organism—such as for example, a cellular surface or a karyokinetic figure. If the form is reproduced—and to the extent that it is reproduced—the experimenter can argue from the causes at work in his model or reproduction, to the causes at work in the organism. His conclusions may not be valid, because quite similar or even identical appearances may be produced in different

* 1925. *Elements of Physical Biology*, Baltimore.

ways, especially in different media; but his hypothesis is legitimate, since, as Aquinas * long ago pointed out, all that we can ask of a hypothesis of this kind is that it should correspond to appearances.

5.

Nevertheless, if we go on to deduce from the fact that forms identical with those in living beings may be produced by the action of physical and mechanical forces in inanimate matter, that the organism is a *mechanism*, or that life is simply a complex set of physico-chemical reactions differing only in the degree of complexity from those occurring in inanimate nature, we shall be wrong.

The vital movement, taken as a whole, is *essentially adaptive*, or, in other words, directed to the attainment of ends advantageous to the organism itself and to its maintenance in existence. This perpetual adjustment to changing conditions both within and without the organism has always been acknowledged to be the characteristic feature of vital action, admirably defined by Aristotle and the medieval philosophers in the statement that life is an "immanent movement."

In non-living substances there is nothing comparable to adaptation. There are changes of various kinds resulting from interactions between substances, but the trend of these changes is not toward the maintenance in existence of these substances. The action of non-living substances is a *transitive* action.

Now, if the forces acting in every part of the organism are in all respects the same as those acting in non-living materials—as they must be if physico-chemical or physico-mathematical explanations based on phenomena of the inanimate world are adequate when applied to vital activities and forms—then the organism is merely an *aggregate* of non-living materials, *i.e.* of elements, no one of which has in itself any adaptive capacity. But an aggregate of this kind cannot have any more adaptive power than any one of the elements composing it. Where there is a series of such elements, acting one upon the other, since each of the successive actions will be non-adaptive, the complete series and the end result will also be non-adaptive.

Organisms are frequently compared to machines. Machines are aggregates of elements juxtaposed in such a way that the result of their combined action and interactions is the production of some desired effect. The effect is always an effect external to the machine and is never directed to the maintenance in existence of the machine itself. Automatic regulatory mechanisms (such as automatic oiling arrangements) indeed exist in some machines, but these are no more adaptive in any real sense than ball-bearings. They reduce the noxious effect of the interaction between various parts and retard the break-up of the aggregate, but they do not transform the noxious effect into a beneficial one, and have no positive adaptive significance whatever. Therefore, if organisms are merely aggregates of elements, each of which, considered in itself, is identical with some non-living element, then they can have no adaptive power.

But the purposeful character and adaptive significance of organic structure and function is undeniable. It is therefore impossible that living organisms can be mere aggregates of inorganic elements. There is indeed a sense in which any aggregate is something more than the sum of its parts considered as existing independently. The difference is, however, simply due to the *relations* arising between the juxtaposed elements. No *qualitative* difference of the type

* *Commentary on the de Coelo of Aristotle*, Lib. II, lect. 17.

we observe in comparing inanimate aggregates with living beings can be produced in this way.*

Thus, although the idea that vital phenomena can be resolved into physico-chemical interactions between elements identical with those of the non-living world is justifiable methodologically, *i.e.* as an attitude taken for the purpose of attacking a problem, it is not justifiable rationally.

In his fascinating and admirable book *Growth and Form*, Professor D'Arcy Thompson asserts that " Like warp and woof mechanism and teleology are woven together, and we must not cleave to the one and despise the other; for their union is ' rooted in the very nature of totality.' "

This statement is, in a certain sense, quite acceptable. Nevertheless, it is impossible for the vital movement to be at the same time a teleological and immanent movement and a mere effect of the interaction of inanimate elements in which only non-adaptive or transitive movements can exist. Between mechanism and teleology there can be no union.

6.

The real problem is thus to explain the successes of the physico-mathematical method in a field in which it simply cannot be (absolutely speaking) an adequate method of treatment.

In order to simplify the problem, let us consider only organisms in which nothing in the way of mental life obviously exists and in which life is restricted to its simplest manifestations—nutrition, growth and reproduction.

The scientific study of an organism has as its object the demonstration of regular connections between certain observable and mensurable properties.

This connection may be either (*a*) a connection of sequence (efficient causation) or (*b*) a connection of simultaneity (material causation).

Thus, suppose we observe at any given instant the form of a cell. At this same instant the cell will present certain physico-chemical properties, which constitute the substratum or material cause of its form. If all these physico-chemical properties, assembled exactly as they are in the organism, are given, even in a non-living system, the form presented by the system will be identical with that of the cell. If, however, we consider the subsequent fate of the aggregate, as compared with the living organism, we arrive at a very different result. The interaction between the parts of the organism is normally an adaptive reaction, whereby the organism continues to exist and develop. The interaction between the parts of the aggregate is non-adaptive and can lead only to the disintegration of the aggregate. An analogy will perhaps make the point clear.

Let us imagine an artist in the act of painting a portrait. At any given moment the spot of colour on the painting corresponds to a certain position and form of the brush touching the canvas, the position of the brush to a certain form of the hand grasping it, with which is correlated a certain position of the arm and an attitude of the body as a whole.

If we place before a canvas a lay-figure representing the painter holding a brush like his, bearing the same kind and amount of colour disposed in the same way, and arrange everything exactly as it is in the living painter, the spot of colour made upon the canvas will be exactly the same.

But the next instant the identity in the effects produced by the artist and the lay-figure will disappear. The artist will continue to paint, but the lay-

* We must reject absolutely the statement quoted by Lotka (*l.c.*, p. 77) from G. A. Sala, that " Life is a system of relations rather than a positive and independent existence."

figure will remain motionless if rigid, or topple over if flexible. If the artist is pushed he will (or can) rectify his position and go on painting; the lay-figure will fall to the ground.

This difference between the living and artificial artists is equally evident between such systems as the dividing egg of a Mollusc or an Echinoderm and an aggregate of soap-bubbles. The form of the individual cells of the embryo, the arrangement of its curved surfaces and planes, can be exactly imitated by an aggregate of bubbles, as was shown by Robert. We may infer (using the argument by analogy) that these similar effects are due to similar causes. Nevertheless, in a few moments the aggregate of soap-bubbles will break up and disappear, while the embryo will continue to develop.

In later stages, when the capillary phenomena become obscure and incapable of experimental reproduction, "various authors, including Robert himself," says Professor D'Arcy Thompson, "have been inclined to argue that the physical phenomena die away and are replaced by agencies of a very different order. . . . But we have no evidence whatsoever," he continues, "that at this point or that point the dominion of the physical forces over the material system gives place to a condition where agencies at present unknown to the physicist impose themselves on the living matter and become responsible for the conformation of its material fabric." It will be evident from what has been said, that some careful distinctions must be made here, and that Professor D'Arcy Thompson's statement can be accepted only with certain reservations.

It is quite true that if we reproduce in an inorganic aggregate the exact physico-chemical conditions present in the organism at a certain moment, the form presented by the organism at that moment will, *ipso facto*, be produced in the aggregate. There is no reason to suppose that there is any part or any stage of the organism in which the form, at any given instant, could not be thus reproduced in an inorganic aggregate, or that such difficulties as may be encountered in this direction are due to anything more than the complexity of the problem.

The value of the inferences we make from a real or an imaginary reproduction of this kind, as explanations of the material causes of the organic form with which we are dealing, depends, not simply upon the perfection of our reproduction—since we can make a better morula out of beeswax than we can out of soap-bubbles—but rather on the extent to which we utilise in obtaining it, the physico-chemical forces really acting in the organism. The causes involved in the manufacture of a beeswax gastrula are quite different from those acting in the real gastrula. Rhumbler's imitation of gastrulation in a model in which the cells are represented by steel rings is also of rather doubtful value. The soap-bubble aggregate, being liquid, seems more likely to teach us something about the real causes involved. Nevertheless, as a little consideration of our analogy of the painter and the lay-figure will show, the same result can be obtained by different arrangements. Different constellations of physico-chemical properties can be material causes of forms which are practically, or indeed, absolutely identical.

7.

Let us suppose, however, that we are able to take a living organism point by point and stage by stage, and, utilising inorganic aggregates presenting in every case physico-chemical properties indistinguishable from those presented by the organism at the instant considered, reproduce the entire galaxy of its forms, what would be the significance of this result?

The answer is that such a result—which in our opinion involves no formal impossibility—would not have the slightest value as indicating that the living organism is a mechanical system, or an aggregate of elements each of which is in itself inorganic or non-living. The result obtained would constitute simply an analogical view of the living organism artificially decomposed into a multitude of discontinuous non-living phases or moments. The juxtaposition of these moments does not constitute the vital movement, because any one of the phases, taken separately, will resolve itself into its constituent elements the instant after it has been built up—just as the aggregate of soap-bubbles, though reproducing, in virtue of properties of liquids which it shares with the developing embryo, the form of the morula, disintegrates rapidly simply because of the natural tendencies of the substances composing it. No matter how little difference there is between two successive phases, there is no direct connection between them.*

The disintegration of the aggregate is, of course, due to the fact that the substances composing it are in a condition of unstable equilibrium with regard to each other and to the environment. The process may be considered as ended when equilibrium is reached. During the passage from unstable to stable equilibrium the materials of the aggregate may exhibit movements similar to those exhibited by the organism. Such movements may also be produced in artificial systems of various kinds, and here, as in the case of form, we may have similar movements in very different materials, as in mechanical models to show the movements of limbs or in somewhat similar materials, as in the imitations of protoplasmic streaming movements or of the karyokinetic phenomenon in cell division, produced by Bütschli, Leduc and others. These are sometimes described as reproductions of vital movement. They are, in reality, simply imitations of the *spatial* movement of certain parts and particles of an organism, and have nothing in common with vital movement which is simply another name for adaptation. Their significance is exactly the same as that of imitations of organic morphology.

An aggregate of inorganic materials may present physico-chemical properties indistinguishable from those of the organism and a form or change of form, correlated with and dependent upon its physico-chemical properties; yet such an aggregate will never present the essential quality of living substance—the adaptive or immanent movement. Its fate can only be degeneration, whether this occurs slowly or rapidly.

8.

The question then arises, in what way does this aggregate differ from the organism whose properties it is supposed exactly to reproduce? We have already said that it differs in the effect produced upon it by environmental changes, or, more generally, in the general trend of the changes that occur in it, these changes being, in the organism, on the whole, of an adaptive nature, *i.e.* of such nature as to preserve the existence of the organism. This is not a hypothesis, it is a fact, and indeed the most evident fact in the whole of biology.

* The point we wish to make may be made clear by analogy with the cinematograph. Owing to an optical illusion, the succession of pictures of moving objects, thrown on the screen, is not recognisable *as a succession*, but appears to be a *continuum*. If a stereoscopic effect and the correct colours could be obtained, it would be visually indistinguishable from reality. Nevertheless, it is in fact made up of successive phases having each an independent origin. One pictorial phase does not arise out of the preceding phase, as in the case with the phases of movement in nature; each depends independently on the camera and its operator.

Behind this fact there is not, according to the views here set forth, anything accessible to *scientific* investigation. The whole of the preceding argument is, in fact, in support of the idea that the living being is, in a certain sense, something *sui generis*—a point where something new, which is not merely a complexity susceptible of resolution into simpler elements, makes its appearance. The properties of this new thing are to the senses like the properties of inanimate things: I mean that animal heat is not in itself perceptibly different from any other form of heat, or the surface tension of living liquids perceptibly different from the surface tension of inanimate liquids. *But from the interaction of these properties there result teleological effects.*

To suppose that these teleological effects are due to some form of "energy" proper to living beings is idle. No traces of such energy have ever been discovered. The only energies to be found in the organism are those existing in the rest of Nature. To say with the vitalists, that some vital force interferes with or directs or restrains the normal action of the physico-chemical properties of the organism, is to involve oneself in inextricable contradictions, on which, we hope, it is needless to insist.*

The simple truth as to the teleological effects obtained, is that the *living organism obtains them, by means of its properties.* We are indeed so saturated in the nominalist traditions that it is difficult for us to realise that "properties," physico-chemical or otherwise, have in themselves no independent existence and *derive all their reality*, and, consequently, all their operative significance, from the being of which they are properties. This is, however, a fact.

Returning to our analogy of the artist, let us suppose him to be in the act of chiselling a statue out of a block of marble. Whether the tools or the sculptor actually make the statue is an ancient riddle. The answer is, of course, that the sculptor makes the statue *with* the tools, and that he is the *principal* and the tools the *instrumental* cause of the marble figure.

The actual change in the form of the block of marble, its gradual transformation to a statue, is due to the repeated impacts of the chisel. The chisel is thus responsible, in a certain restricted but quite definite sense, for a series of changes leading toward a certain end. Its activity is therefore in this case teleological in character. Nevertheless, the properties of the chisel, as a physical object, are in no way distinguishable (excepting in regard to the effect produced) from those of any other piece of steel, such as a similar chisel lying on a shelf. Its hardness, its elasticity and so forth, are scientifically the same as the hardness, elasticity and conductivity of other pieces of steel and remain unchanged, whether the chisel is producing teleological effects or not.

Suppose, for the sake of argument, that the chisel is an integral part of the sculptor; we shall then be about as close as we can get, by the use of comparisons of this kind, to an exact idea of how the organism pursues and achieves its ends, utilising properties which are not in themselves objectively distinguishable from those presented by inanimate objects. *How* it pursues and achieves its ends *in any given* case is a matter for physiological investigation. *How it is* that it *can* do so is a question to which, in our opinion, there is no answer. One might as well ask why water is wet. We are here face to face with one of the

* The type of vitalism in which "directing energies" or "restraining forces" are postulated is simply disguised mechanism. The forces and energies postulated are considered as exerting exactly the same effect as forces and energies of bodies, whose corporal nature is made as tenuous as possible by assuming that they exert only a passive resistance or act at right-angles to the direction of movement. No such idea is here suggested or implied.

primordial facts which we can *consider* from various aspects and *state* in various ways but *cannot explain analytically*, because it is, in its particular order, the indivisible terminal point of thought.

Thus, again, our imitations in inorganic aggregates of the morphological aspects of the organism in its various stages, though always suggestive and sometimes illuminating, are valueless as demonstrations of the thesis that the organism is a physico-chemical aggregate or a mechanical system. The problem of reconciling the mechanistic deductions from investigations of the physico-mathematical order with the observed teleological and immanent activities of the living being is in reality a mere pseudo-problem, due simply to the misinterpretation of the results obtained.

9.

For the sake of exactitude one reservation must, however, be made. Every organism belongs to some definite species and has certain definite and particular functions and habits. In other words, it pursues certain specific ends in a specific manner. Now it is evidently only in regard to the specific ends it pursues that it will utilise its properties in a teleological manner. Considered in respect to other ends, or in relation to situations to which it is not adapted—which are, to use the common expression, *out of its line*—the properties of the organism will not merely *look* (so to speak) like their inorganic analogues, but will behave like them. In these cases the organism will act exactly like an inorganic aggregate made to imitate it. For example, considered in relation to the normal environment, the physico-chemical properties of a hen's egg have a teleological significance; utilising them, the organism pursues its development. But if we let the egg fall to the floor, the case is quite different. The sequence of events that then occur will reproduce exactly those which would occur in the case of an inorganic aggregate constructed in imitation of the egg.

Do experiments of this type prove that the organism is an inorganic aggregate? The answer here is that they do not, absolutely speaking; but that they do, in a certain relative and very restricted sense. The organism is one in relation to its specific ends; in relation to other ends, it is hardly an organism at all. By *organisation* we mean simply, the arrangement of things in relation to the attainment of some end. The fact that living organisms behave like inorganic aggregates in relation to circumstances to which they have, in virtue of their specific characteristics, no adequate response, is therefore altogether valueless as a proof that they are in no way different from non-living systems. All that this proves is that the powers of the organism are *limited*, as they must be if the organism is susceptible of definition, for the very idea of definition includes and implies the notion of boundaries and limitations. The fact remains that the powers of the living organism are *adaptive* powers of which not the slightest rudiment exists or can exist in any inorganic mechanism.

10.

Conclusion.

The significance of the results obtained by the use of the physico-mathematical method in problems of organic form and movement depends primarily upon the actual direct object of the investigation. This may be either (*a*) the living organism itself, or (*b*) a non-living aggregate considered to be similar or identical to the organism in respect to certain properties.

(*a*) *First Case.* The purpose of the investigation is the collection of quantitative data (measurements of some quality) and their expression in a mathematical equation showing how the different quantitative elements designated in the formula vary in relation to one another. The investigation is regarded as successful when the numerical values deduced from the formula are always found to be correct, when verified by measurements. The method is thus simply a mathematical treatment of measurements having as its sole object the establishment of a mathematical correlation between measurements or quantitative values of the various things considered. It can thus teach us nothing about the real causes or nature of the phenomena studied; * but since it deals with quantities actually existing in the organism it is to this extent a department of biology. In other words, it is materially biological, and formally mathematical.

(*b*) *Second Case.* The purpose of the investigation is the discovery of the causes of organic forms and movements by the investigation of the causes of similar or identical forms or movements exhibited by inorganic or admittedly non-living substances or aggregates of substances. The conclusions drawn from the study of non-living aggregates are applied to living organisms via the argument from analogy. The deductions as to the actual causes of form and movement in the organism, though not by any means valueless, are thus at best uncertain, though they may present in certain cases a high degree of probability.

The most we can hope to obtain from such investigations is, however, an accurate knowledge of the physico-chemical properties constituting the substratum of organic form at any given moment. We may reproduce in inorganic aggregates as many phases in the development of an organism as we please (and there is, strictly speaking, no inherent contradiction in the idea that this process may be carried on indefinitely). If the properties of the inorganic aggregates used are physically indistinguishable from those of the organism (and this is philosophical though perhaps not a practical possibility) then everyone of the series will be an exact morphological reproduction of the organism. But no matter how many phases of development we thus reproduce we shall be no nearer to an explanation of vital activity.

The reason is not simply that the successive phases, represented by the aggregate, *do not* when juxtaposed constitute a *continuum*, but that they *cannot* be phases of a *continuum*, because the properties constituting the substratum of the form of the aggregate at a given moment would not engender, in the moment immediately following, the properties (and the form to which they correspond) in the next phase of development. No matter how perfectly the aggregate of soap-bubbles represents the dividing egg, it does not develop like the egg, but collapses and melts down into a drop of soapy water, because that is the *natural* thing for it to do.

That certain physical movements observed in organisms may occur in an aggregate of inanimate materials in no way affects the preceding conclusion. The mere fact that such physical movements may be reproduced under conditions in no way resembling those found in the organism is in itself a sufficient proof of this contention. Such physical movements, though they are indeed an almost constant accompaniment of life, do not constitute vital movement, which is simply action directed to the welfare and maintenance in existence, of the being exerting it, this type of action being at once the essential characteristic

* Studies of this kind have thus absolutely no bearing whatever in themselves on the question as to whether the organism is, or is not, a mechanism.

of life and the one thing never exhibited in the very slightest degree by any of the imitations of organic forms or movements.

The study of organic movement and form in inorganic aggregates, though undoubtedly of great interest and value, can thus never lead to a complete explanation of life, nor is there any hope that by such methods vital activity can be resolved into physico-chemical reactions characteristic of inorganic matter. The physico-chemical properties of the organism are indeed, considered in themselves, indistinguishable from those of non-living bodies; but the living body uses them to obtain adaptive effects. Until the mechanist can manufacture an aggregate of non-living elements in which adaptive reactions occur, the assertions that living organisms are mechanisms must be considered without foundation.

SOME CERATOPOGONINAE FROM THE TRANSVAAL

By Botha De Meillon, M.Sc.

(South African Institute for Medical Research, Johannesburg.)

[Read June 5th, 1929.]

With Three Text-figures.

The following Ceratopogoninae were collected whilst on a mosquito survey in the Transvaal during the months January to April 1928. Immature stages of midges collected with those of mosquitos were separated and allowed to hatch, but no special efforts were made to collect them in the field.

It is gratifying to find that the majority of the midges are referable to species described by Carter, Ingram and Macfie from the West Coast of Africa and Nyasaland. This has been made possible by the excellent figures of male hypopygia and wing-venations given in their papers.

I am greatly indebted to the authorities of the British Museum (Nat. Hist.) for granting me working facilities in the Museum and access to the collections. I am also very grateful to Mr. F. W. Edwards of the Museum for his kindly advice and criticism.

Culicoides, Latr.

Culicoides schultzei, End.

A single specimen hatched from a pupa taken in a pool.

Locality: Komatipoort, Eastern Transvaal.

Culicoides bedfordi, Ing. & Macfie.

A female closely resembling this species hatched from a pupa taken in a small pool.

Locality: Naboomspruit, Transvaal.

Culicoides accraensis, Carter, Ing. & Macfie.

Numerous specimens hatched from pupae obtained from rot-holes in trees. The adults are not quite typical, but it has not been thought necessary to erect a new species. In specimens at the British Museum (Nat. Hist.) and in the drawing given by Carter, Ingram and Macfie the pale spot towards the base of the wing is always in front of the cross-vein, whereas in the Transvaal specimens the pale spot is actually on the cross-vein. In the male hypopygium the ventral branch of the harpes is relatively longer and narrower than in the West Coast specimens; as this, however, may be due to the hypopygium having been somewhat flattened in the process of mounting, too much importance cannot be attached to it. In other respects the specimens appear to be identical.

Locality: Komatipoort, Rolle Siding, Eastern Transvaal.

Culicoides punctithorax, Carter, Ing. & Macfie.

Adults, all females, were reared from immature stages obtained from a rot-hole in a paw-paw tree. Carter, Ingram and Macfie reared their specimens from

water obtained in a rot-hole in a silk cotton tree. No males were reared so that their identity could not be verified by the hypopygium. The strikingly marked thorax and wing-ornamentation as well as other details, however, leave little reason for doubt as to their identity.

Locality : Tzaneen, Eastern Transvaal.

Bezzia, Kieff.

Bezzia africana, Ing. & Macfie.

One female hatched from a pupa obtained from a pool. This specimen differs from *B. africana* only in having two spines on the fore femora instead of three.

Locality : Letaba, Eastern Transvaal.

Dasyhelea, Kieff.

Dasyhelea nigrofusca, Carter, Ing. & Macfie.

Five males were reared from larvae and pupae obtained from a snail shell in which there was a small collection of water and earth. Carter, Ingram and Macfie obtained their specimens from a rot-hole in a mango tree.

Locality : Leydsdorp Road, Eastern Transvaal.

Monohelea, Kieff.

Monohelea nigeriae, Ing. & Macfie.

Two females resembling this species very closely were reared from pupae obtained in a rot-hole in a tree.

Locality : Rolle Siding, Eastern Transvaal.

Stilobezzia, Kieff.

Stilobezzia limnophila, Ing. & Macfie.

Two males of this small midge were reared from pupae collected in an exposed pool.

Locality : Naboomspruit, Transvaal.

Stilobezzia spirogyrae, Carter, Ing. & Macfie.

One male of this strikingly coloured midge was reared from a pupa collected in an exposed pool.

Locality : Naboomspruit, Transvaal.

Ceratopogon, Mg.

Subgenus *Brachypogon*, Kieff.

Brachypogon was founded by Kieffer on a description of *vitiosus* by Winnertz in which the lower branch of the media is wanting. Edwards (*Trans. Ent. Soc.*, LXXIV, 1926) has reduced it to subgeneric rank, the absence of the media, which at first sight appears to be so striking, being the advanced stage in its gradual disappearance. He considers the subgenera *Ceratopogon* s. str. (= *Psilohelea*), in which *M*2 is complete or only narrowly interrupted at the base and *Isohelea*

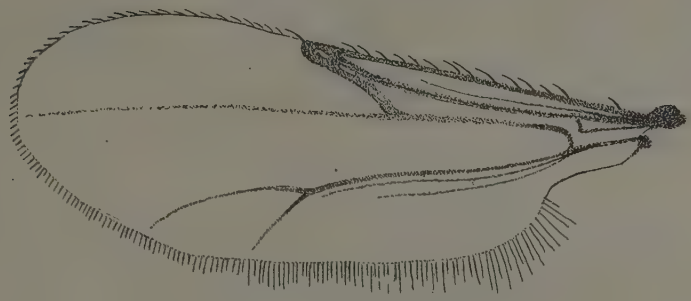

Fig. 1.—*Brachypogon africana*, sp. nov., Wing.

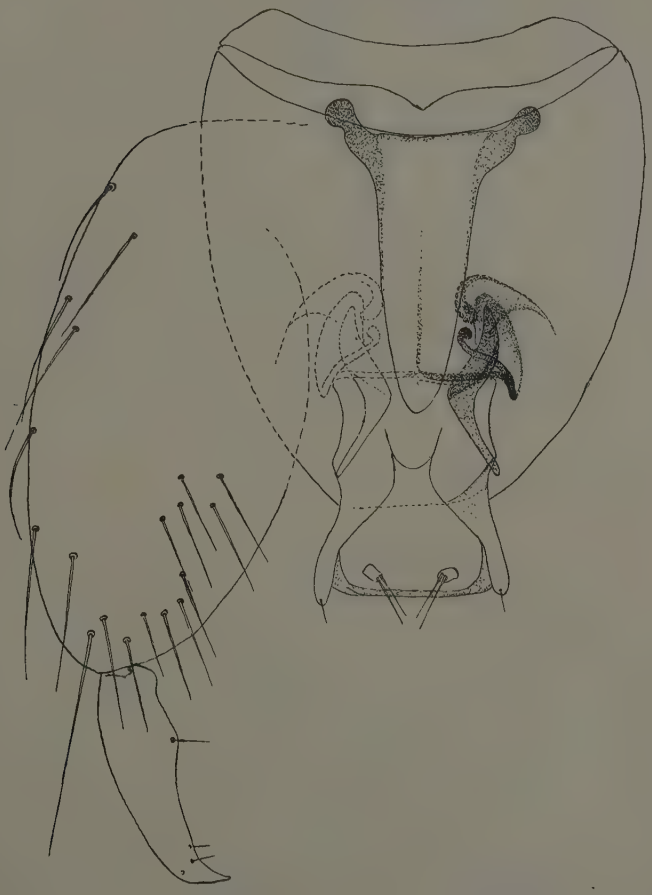

Fig. 2.—*Brachypogon africana*, sp. nov., Hypopygium.

(=*Anakempia*), in which *M*2 has about the basal half missing, to be intermediate stages.

No species of *Brachypogon* have hitherto been recorded from the Ethiopian Region; Kieffer has recorded species from Europe and Australia.

Brachypogon africana, sp. nov.

Wing length (one male), 1·2 mm. *Head:* dark brown, occiput clothed with dark hairs. Eyes bare, widely separated above. Clypeus dark brown; proboscis lighter in colour. Palpi brown, bearing a few dark hairs; third segment very slightly swollen with a sensory pit. *Mouth-parts* poorly chitinised. *Antennae:* flagellum brown, tori brown; last three antennal segments longer than the more proximal ones, the terminal segment shortest of the three and somewhat pear-shaped. *Thorax* very dark brown, almost black, sparsely clad with hairs; scutellum dark brown with one centro-marginal seta and a lateral seta on each side. Postscutellum very dark, bare. Pleurae a shade paler than the thorax. Halteres large and conspicuous with pale crowns and slightly infuscated bases. *Legs:* coxae dark brown, femora, tibiae and tarsi paler; knee-joints and fifth tarsi slightly infuscated; claws small and equal on all legs. *Wings* (fig. 1): milky, unadorned; *M*2 wanting; no micro- or macrotrichia; costa reaches just beyond the middle of the wing; two radial cells small and indistinct; fork of the cubitus beyond the cross-vein but before the end of the costa. *Abdomen* very dark brown, venter paler especially proximally. *Hypopygium* (fig. 2): 9th tergite is nearly as long as the side pieces; it bears a delicate hair situated on each distal angle, internal to these are two small papillae each bearing two small hairs; the side pieces are oval in shape, the claspers are relatively short each bearing a few small hairs and having a beak-like termination. The parameres are very complicated and consist of two main parts, one, the more proximal, has an internal projection, which, meeting a similar projection from the other side forms a narrow horizontal bridge; on each side of the bridge there is a chitinised piece projecting upwards at right angles to it; the other main part of the paramere is more distal and consists of two separate pieces each bent in the middle. The aedoeagus reaches just beyond the chitinous bridge of the parameres and is somewhat Y-shaped, the stem being very broad and long and the arms short and narrow.

A single pupa was collected in an unshaded pool.
Locality: Naboomspruit, Transvaal.

Palpomyia (Mg.), Kieff.

Palpomyia nigrithorax, sp. nov.

Wing length (one male), 2·4 mm. *Head:* eyes widely separated; occiput black with dark hairs, clypeus shining black; proboscis and palpi very dark brown; tori black; flagellum dark brown with paler plumes. *Thorax* shining black with a small frontal tubercle; scutellum black with four dark marginal bristles; postscutellum shining black, bare. *Wings* clear, no macrotrichia; second radial cell slightly infuscated and about three times as long as the first radial cell; costa reaches well beyond the middle of the wing; fork of the cubitus slightly distal to the cross-vein. Halteres very dark, paler basally. *Legs* dark brown, first and second tarsi of all legs paler, third, fourth and fifth tarsi slightly infuscated especially the fifth; claws of all legs small and equal; fourth tarsi cordiform, fifth unarmed; fore femora with three, midfemora with one and hind femora with two black spines near their apices. *Abdomen* very dark brown. *Hypopygium* (fig. 3): side-pieces slightly swollen basally, claspers with an apical beak-like termination; ninth tergite as long as the side-pieces,

slightly notched at the distal end and bearing a few long setae and some small hairs; paramere with the distal end expanded bearing a sharp-pointed projection; aedoeagus nearly as long as the side-pieces shaped like an inverted U with the distal end bearing two small papillae.

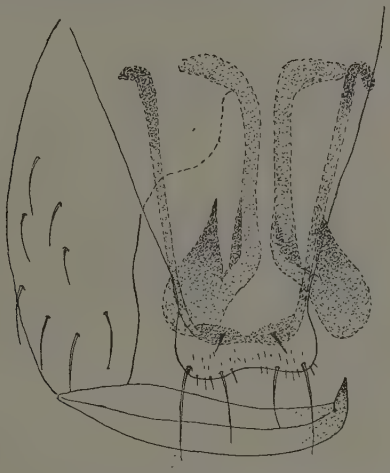

Fig. 3.—*Palpomyia nigrithorax*, sp. nov., Hypopygium.

Pupa collected in an exposed pool.
Locality: Letaba, Eastern Transvaal.

BUTTERFLY MIGRATIONS IN BRITISH GUIANA. II

By L. D. Cleare, Jnr., F.L.S.

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[Read October 2nd, 1929.]

Two Maps.

The present communication is offered as a continuation to my previous paper on the subject in the *Transactions of the Entomological Society of London* for 1921. Further migrations of butterflies together with observations on the swarming of the insects, and the alleged food-plant, are now recorded. These have occurred either since the previous publication, or at least have not been recorded previously by Williams or myself, and otherwise would not be readily accessible to entomologists. Under the latter category come the accounts of the migrations observed by Mr. Harold W. B. Moore, which appeared in a local newspaper and which are included here with his permission. Other individuals who have contributed observations are acknowledged elsewhere; to all I tender my thanks. I should like to make special mention, however, of Captain C. M. Gibson, R.N., O.B.E., Messrs. G. Brinsley and J. B. R. Pedder, all of the Essequibo River Survey, for the series of observations made on that river during the past couple of years.

Migrations.

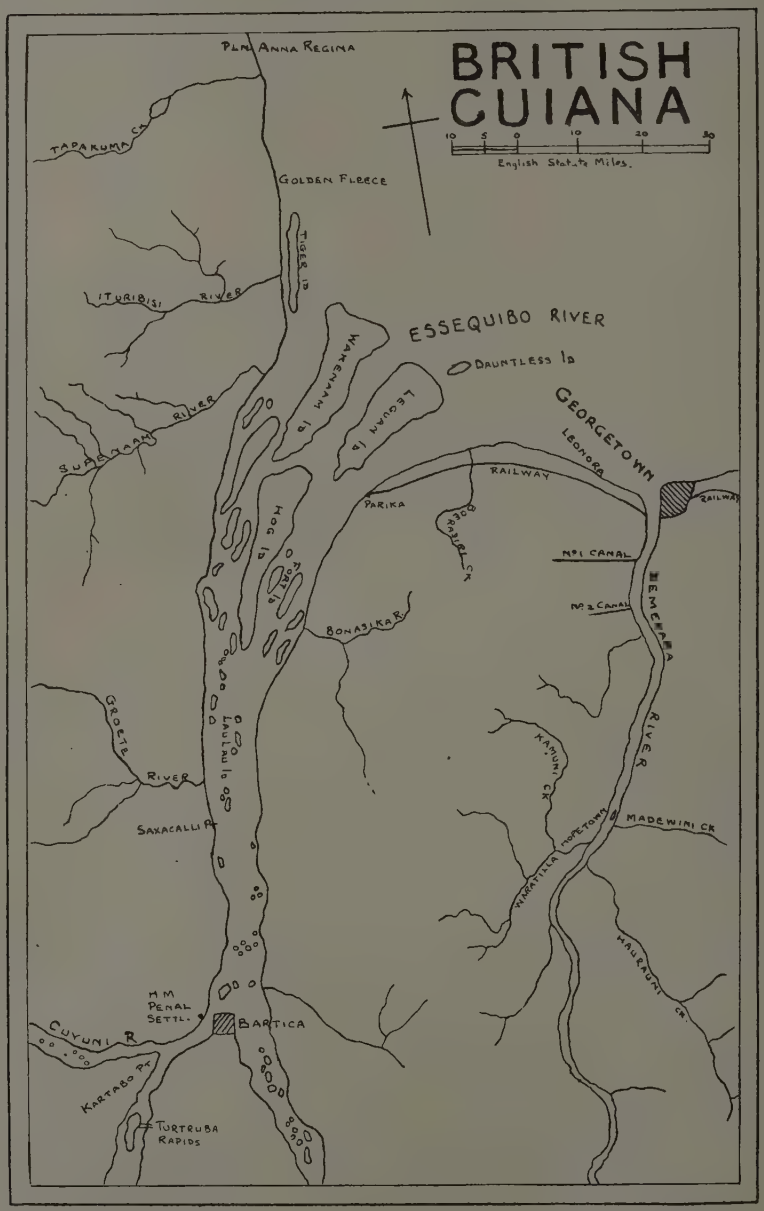
(1) 1915. Mr. H. W. B. Moore in the *Daily Argosy* of this Colony for June 28, 1921, records a migration of *Callidryas eubule*, L. (*Catopsilia sennae*, L.), which occurred on June 17, 1915, at Plantation L'Union on the Essequibo Coast, together with another which occurred in 1921, and which is dealt with later. With regard to the former migrations Mr. Moore writes :—

" The day was fine, hot and beautiful, opening with a south wind, which soon shifted to the south-east and blew from that quarter for most of the day. The butterflies were journeying from north to south. They formed a very narrow stream of only a few yards in width, and the flight lasted till well into the afternoon."

He adds that he was informed that on the previous week there had been an all-day flight of millions along the coast, also from north to south, and that the butterflies had been observed at Taymouth Manor and Golden Fleece as well.

(2) 1920. Mr. H. A. Frere, formerly Superintendent of His Majesty's Penal Settlement, Mazaruni River, reported on 1st October, that " sulphur butterflies " were migrating south-east, and on 8th October, gave additional information as follows :—

" Duration of migration—8 to 11 a.m.; speed at which insects travelled—10 to 12 miles an hour; direction of migration—due south (magnetic); prevailing wind—a land zephyr (they do not appear to travel when a breeze gets up); number of insects crossing a given distance—20 per minute across a line 25 yards long; height insects were travelling above ground—low, not more than 3 feet on the average."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LEGUAN ID
GEORGETOWN
LEONORA
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PARIKA
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TARLOW CR
No 1 CANAL
No 2 CANAL
DEMERARA RIVER
BONASIKAR
GROETE RIVER
HOG ID
LAUTIN ID
KANUNI CR
MADEWINI CR
TOPETONG
SAXACALLI
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BARTICA
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KARTABO PT
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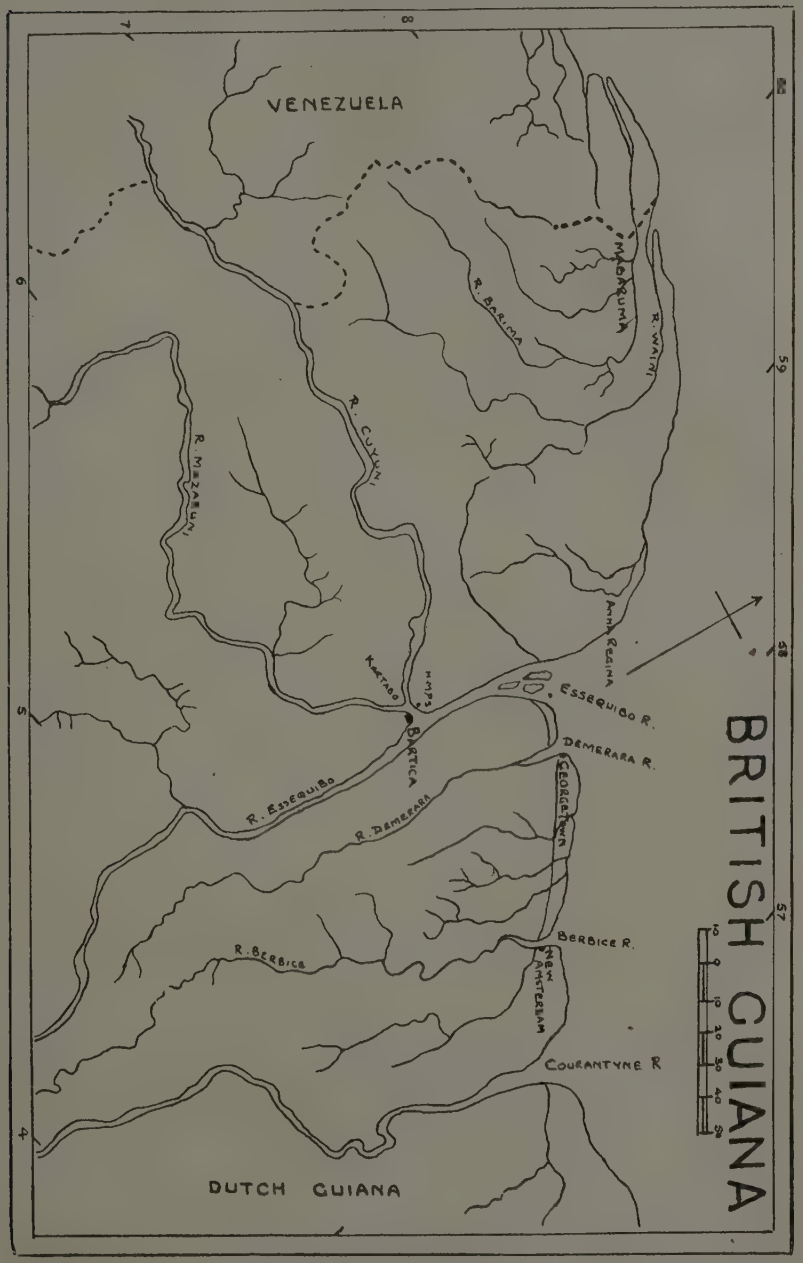
VENEZUELA
R. BARIMA
MORUKUMA
R. WAINI
R. CUYUNI
R. MAZARUNI
KAITAOO
ANNA REGINA
ESSEQUIBO R.
DEMERARA R.
BARTICA
GEORGETOWN
R. ESSEQUIBO
R. DEMERARA
BERBICE R.
NEW AMSTERDAM
R. BERBICE
COURANTYNE R
BRITISH GUIANA
DUTCH GUIANA

It was stated in addition that " weather had been dry lately "; Mr. Frere added that he only noticed these migrations once a year, and the general direction was always the same, about due south. From the words " sulphur butterflies " it may be assumed that the insects were *Catopsilia sennae*, L.

(3) 1921. The second migration of *Callidryas eubule* (*sennae*) recorded by Moore occurred on June 25, 1921. He writes :—

" On Saturday morning, while returning to town by steamer from Adventure, I observed a broad stream of yellow butterflies (*C. eubule*) on one of their customary mid-year migrations across the Essequibo River. . . . The general direction of their flight was towards the south-east, as far as I could see, while the wind was blowing from the east."

The butterflies were observed around the island of Wakenaam and crossing the river in the direction of the west coast of Demerara.

(4) 1924. Several flights of butterflies (? *C. sennae* or *C. statira*) were reported as having occurred about the middle of July at Wakenaam Island, Essequibo River, and the following data is given with regard to a migration that took place on July 12, 1924.

" Direction of migration—north to southerly direction; direction of wind —generally south to south-east or calm, mostly ' land breezes.' "

The observer added that the insects seemed to travel against or almost against the wind. Unfortunately, there is no information that would aid in fixing the species concerned. (P. E. N. Corlette.)

(5) 1926. The year 1926 was the most remarkable of those now dealt with as far as butterfly migrations are concerned, for during that year a very large migration appears to have taken place over an extensive area of coast-lands in the month of July. A number of observations of this migration were obtained from different sources and are compiled below :—

The first observation on this migration was made on July 7, at Fort Island on the Essequibo River, as shown by the following extract from the log-book of the Survey Ship, " Lady Longden," and kindly supplied to me by Captain C. M. Gibson, R.N., O.B.E., who was in charge of the survey.

" July 7, 1926. At Fort Island (anchored near the stelling). Calm and light winds from the shore. Flocks of yellow butterflies crossing bow from Fort Island to mainland."

It was later ascertained that the direction of the flight was a general west to east direction.

Butterflies were reported as having been seen on the west coast of Demerara, either on the 7th or 8th July, when " a large swarm " were observed passing over Plantation Leonora. The observer was not clear as to the exact date, but is certain that it was either on the 7th or 8th July. (John I. King.)

On the 8th I was informed that there were " millions of butterflies " on the No. 1 Canal, West Bank, Demerara River, at Plantation Uitkomst. From the position of the plantation and its comparative closeness to Plantation Leonora, I am inclined to believe that the date of the previous observation was July 8. (G. De Fleury.)

On July 8, " sometime between midday and 3 p.m. . . . yellow butterflies were seen to be flying in large numbers (on the Essequibo River) from Hog Island towards the mainland in a direction about south-east. A light wind blowing from the east brought a shower of rain, on the commencement of which the butterflies turned round and flew back to the island. As soon as the rain stopped the butterflies set out again." (J. B. R. Pedder.)

The point of observation Mr. Pedder informed me was about 4 miles from the northern end of Hog Island and about 200 feet from the shore.

On July 19, Mr. S. Bracewell, Government Geologist, observed butterflies migrating at the Hills Estate near the mouth of the Mazaruni River and for a short distance beyond the Mazaruni River itself. The insects were observed first about 10 a.m., and were crossing from the left to the right bank of the river, that is in a general direction from north by west to south by east. The direction of the wind at the time was approximately from west-south-west to east-north-east, and the insects were therefore flying across the wind. The insects were quite noticeable to a casual observer, and were estimated by Mr. Bracewell as "one insect to every three yards or so." They were flying about 10 feet above the surface of the water, and the speed of their flight was estimated as not more than 10 miles per hour. The width of the swarm, it is believed, must have been at least 4 miles wide. The insects were not observed at Tatruba Falls, which is about 7 miles up river beyond the Hills Estate, at 12 noon. The migrations had ceased at 3 p.m. when the party returned to the Hills Estate, and the direction of the wind had changed by that time. The insects were mostly the "yellow butterflies" (? *C. sennae*), but some were white (? *Catopsilia statira* or *Appias drusilla*).

On the 20th yellow butterflies (? *C. sennae*) were reported in numbers along with deep orange (? *C. philea*, L.) as flying off the coast, and were observed from the coastal steamer proceeding to the North-Western District. The data given in connection with the observation is that the butterflies came from "the left side of the ship," and that the flight was "in the direction of Georgetown." The position of the steamer at the time was between Hampton Court and Anna Regina and about 5 miles from the land. In this position "from the left side of the ship" the insects would be flying out to sea. The butterflies were flying about 15 feet above the sea, and the speed of the flight is given as about ½ mile per hour. The data are supplemented by a note that "there was a regular stream of butterflies which seems to have been endless." The sea was calm with a light breeze blowing off the land. (W. H. Matthews and E. J. Beckett.)

Although there are evident inaccuracies in the above observation, the point brought out is the occurrence of a migration on that date and in that locality.

On the 20th about 4.45 p.m. white and yellow butterflies were observed in Georgetown, and the general direction of the flight was north to south, but by 6 p.m. they were not to be seen in the same area.

About 9 p.m. on the same night, however, a single specimen of *C. statira* was blown into, and again out of, my house. Just about that time there was a sudden gust of wind, and in the north-west sky heavy clouds and lightning could be seen and apparently a sharp thunderstorm was taking place some distance away in that direction. It was observed at the time that the insect had a distinct and peculiar odour.

On the morning of the 21st, butterflies were observed to be migrating first about 8.35 a.m. in the eastern part of the town, and were later seen in various parts of the town as far as its western boundary, the Demerara River, up to 9 a.m. The general direction of the flight was north to south. The direction of the wind at 9 a.m., taken at the Meteorological Station in the Botanic Gardens, at the eastern boundary of Georgetown, was south-south-west.

Between 8.35 and 9.30 a.m. a few of the insects were collected, when it was observed that more than one species was concerned. Between 9 a.m. and 11.30 a.m. observations were made on the migration in various parts of Georgetown and specimens collected. From these observations it was found that the width

of the migrating swarm was at least as wide as the city, that is 1½ miles across. The butterflies were observed repeatedly at different kinds of flowers, and the principal flowers noted as visited by the insects were *Ixora*, *Coralita*, *Hibiscus*, Demerara Primrose (*Asystasia scandens*) and Flamboyant, while they were also seen at flowers of *Duranta*. It may be said that the butterflies appeared to be mostly attracted by red flowers, although large numbers were attracted to the Primrose. Specimens of *Cydimon leilus* were observed amongst the migrating insects, apparently migrating also, but in very much less numbers than the white and yellow.

Between 9.50 and 10 a.m. a count was made of the insects crossing a line over a space of 100 to 150 yards. In five minutes 70 butterflies of the prevailing species, apart from *Cydimon*, were thus counted, an average of 14 insects per minute. The insects were travelling at a height of from 4 to 20 feet above the ground.

Between 10.10 and 10.30 a.m. some of the insects were collected at the Fort situated at the mouth of the Demerara River. Here again it was noticed that the migrating insects were composed of several species, and apart from the "yellows" (of which there appeared to be at least three species) there were many *Cydimon leilus*, and an even larger number of another species—a brown butterfly—none of which were captured at the time owing to the height at which they were travelling (about 20 feet above ground) and the speed of their flight, estimated at the time to be about 20 miles per hour. The yellows and whites were travelling much slower, about 10 to 15 miles per hour, and the *Cydimon* at about the same speed. The majority of the butterflies taken at this point were caught as they visited the flowers of a wild vine called by the East Indians "Coreilla" (*Momordica charantia*) or of those of the "Baby Cucumber" (*Melothria pendula*), and a few at the flowers of a *Cissus* (? *sicioides*) vine. The flowers of "Coreilla" are a bright orange colour and quite conspicuous, being about 1½ inches in diameter; those of the "Baby Cucumber" are white and about the same size as those of "*Coreilla*," while the flowers of the *Cissus* are of a creamy-yellow colour and rather inconspicuous. These plants, all vines, were growing together in a somewhat tangled mass and were the first flowers that butterflies arriving at this point would encounter. From the end of the groyne at this place it could be clearly seen that the butterflies were all coming from the direction of Dauntless Island, and not from the opposite bank of the river, that is, from a north-westerly direction. At 10.30 a.m. the direction of the wind was observed to be roughly the same as that from which the butterflies were coming, viz. north-west. In other words, the butterflies were flying *with* the wind. A further collection was made on the Sea Wall about 11 a.m. about the flowers of wild ochroe plants (*Malachra capitata*), which are yellow and small, being rather inconspicuous.

The coastline was then followed for about 4 miles beyond the mouth of the river, with the object of ascertaining the width of the migrating swarm. The butterflies were noticeable along the Sea Wall as far as Kitty Groyne, which is in line with the eastern boundary of Georgetown and about 1½ miles east from the mouth of the river. Between this point and Turkeyn, just beyond the fourth milestone, although the insects were to be seen they were by no means as numerous as along the Sea Wall, and it was apparent that one was at the end of the swarm.

At 11.30 the butterflies were still migrating, the direction of the wind being then roughly north-west. The migration was still in progress though much reduced, and had practically ceased at 1.30 p.m.

The butterflies were again observed in Georgetown between 4.50 and 5.0 p.m. and a few " Browns " were seen flying on Kitty Beach, all from the sea inland, between 6.15 and 6.30 p.m.

The following are the directions of wind from observations made during the migration and from data supplied by the Meteorological Station at the Botanic Gardens, Georgetown.

Time.	Direction observed.	Direction at Met. Station.
9.00 a.m.		S.S.W.
10.30 a.m.	N.–W.	N.N.W.
11.00 a.m.	N.W.	N.W.
11.30 a.m.	N.–N.W.	N.–W.
1.00 p.m.	Calm	Calm to 1.30 p.m.
1.30 p.m.	Calm	S.W.
1.50–3.05 p.m.		Calm
3.10 p.m.		S.E.
4.30 p.m.		Calm
6.00 p.m.–midnight		Calm

It will be seen that the direction of the wind as observed in the field are in close agreement with the readings at the Meteorological Station.

The following observations from the Deck Book of the S.S. " Lady Longden " were supplied by Captain Gibson :—

"*July* 21, 1926.	Moving from Fort Island to Kokurti.
11.30 hrs.	Left Fort Island anchorage.
11.40 ,,	Ran into a stream of yellow butterflies flying across the river, direction of flight, S. 55° 00′ E.
12.05 ,,	Belt of butterflies passed.
12.26 ,,	Another belt begun.
13.10 ,,	Arrived at Kokurti."

Note.—From the above it is possible to estimate the width of the first stream as $1\frac{3}{4}$ miles.

Subsequently these observations were supplemented by the following note : " I have in this case to refer to memory. I believe the stream of butterflies became thinner and practically ceased before we reached Kokurti."

On the 22nd the butterflies were observed to be migrating again at Georgetown between 10 and 11 a.m., but in very much less numbers. *Cydimon leilus* were also still migrating. On the 23rd and 24th a few stragglers were noted as passing over the town, and on the 25th a few stragglers of *Catopsilia statira*, *Cydimon*, and the " Browns " were observed to be flying inland from the sea over the Sea Wall at Turkeyn, which is about $2\frac{1}{2}$ miles beyond the eastern boundary of Georgetown, and about four miles east of the mouth of the Demerara River. There were no observations on the 26th.

On the 27th one specimen of a " Brown " was collected on Kitty Beach at 7.10 a.m. as it was flying. This insect proved to be a *Coea cadmus*, Cram. That this was the species constantly observed during the migration seems certain, for before this insect was taken it was noted in flight during the migration that the wings were distinctly hooked, a feature of this insect and not possessed by *Anosia plexippus*, the only other insect with which it was likely to be mistaken. There is another point bearing on the species that is worthy of mention here.

On the 23rd I observed several of these insects feeding on a damaged and decaying soursop fruit (*Anona muricata*) at the Experimental Fields, Botanic Gardens, Georgetown, together with a few *Selenophanes cassiope*, Cram., and the black wasp *Synoeca surinama*, L. Both of the butterflies are somewhat alike in general coloration and both possess distinctly hooked wings, and it would be possible to mistake them on the wing when travelling at a good speed, although the latter species is somewhat larger. They are neither of them usually taken in the area. There is little doubt in my mind that *Coea cadmus*, Cram., and *Selenophanes cassiope*, Cram., were both taking part in the migration, and were the " Browns " observed and noted previously.

On the 28th I have a note that " Browns " were apparently still migrating, and ten of the insects were observed passing in Georgetown between 11.30 and 11.50 a.m. They were flying from north-west to south-east, and there was a calm at the time. On the 30th I observed a " Brown " and a single " yellow " (dark orange—? *C. philea*, L.) coming inland over Kitty Sea Wall from north to south between 6.15 and 6.30 p.m. On the 31st Mr. C. Williams again collected one specimen of *Coea cadmus*, Cram., on Kitty foreshore flying from the sea inshore at about 3 p.m.

From the above observations it would appear that a huge migration of butterflies took place over the coastlands of the Colony between the 7th and 31st July. The species engaged in this migration included *Catopsilia statira*, Cram.; * *C. philea*, L.; * *C. agarithe*, Bdv.; * *C. sennae*, L.; * *Appias drusilla*, Cram.; * *Cydimon leilus*, L.; *Coea cadmus*, Cram.; and probably *Selenophanes cassiope*, Cram. As to the proportions in which the various species and sexes occurred, I can offer information only with regard to the Pierids. Of a total of 75 Pierids collected at various points in Georgetown on 21st July, the species are represented in the following numbers and proportions—*C. statira*, 53 insects or 42·0 per cent., of which there were 35 ♂♂; *C. philea*, 2 insects, 1 ♂, 1 ♀; *C. agarithe*, 1 ♂; *C. sennae*, 4 insects, 3 ♂♂, 1 ♀; and *Appias drusilla*, 15 insects, of which there were 11 ♂♂.

On the 22nd butterflies were again observed on the west coast at the back of Plantation Leonora, and were reported as flying from south to north, and across the " Service " or Boerasirie Canal, between 12 noon and 1 p.m. (John I. King.)

(6) 1927. Captain Gibson and Mr. Brinsley sent me the following observations on a large migration of Hesperids and Pierids which took place in July and August on the Essequibo River.

" A large migration of small brown butterflies, flying very fast against a strong breeze was noticed passing over from west to east from Saxicalli Point to Ithaca at 11 a.m. on Friday, 15th instant, one yellow was among them. We were unfortunately unable to secure a specimen.

" 18*th July*. Brown butterflies observed flying west to east near Pairuwa Island. Weather dull, sky cloudy, frequent showers at intervals. Time, 9 to 11 a.m."

On the 19th July a further observation was received, saying that the migration of the butterflies referred to above was still in progress, and forwarding two specimens of the insects. The note stated :—

" Brown butterflies observed flying west to east near Stampa Island. Weather as day before, but clearer. Their speed is estimated at something between 60 and 30 miles per hour. This migration was noticed both yesterday and to-day, in addition to the day mentioned before. Time, 9 to 11 a.m.

* Determined by Mr. G. E. Bryant, through the Imperial Bureau of Entomology.

" 22*nd July*. Migration continuing. A few observed for first time flying in the opposite direction. Weather fine, clear and calm.

" 28*th July*. The following observations were made :—

" Weather, a.m., fine and hot.

14.00 hrs. Temperature suddenly cooled by approaching showers and breeze. A few butterflies observed flying from west to east.

14.10 ,, Light showers of rain falling. Enormous flight of butterflies from south to east. Rough estimate of 500 per minute over the launch (32 feet long).

14.20 ,, Rate doubled.

14.45 ,, Shower over; air sultry. Butterflies fewer, about 100 per minute."

" 18*th August*. Swart Hoek, Macauria Island. Yellow and White butterflies observed flying south-east 12.28 hrs. Weather fine and clear."

" 26*th August*. Macauria Island. Brown butterflies flying east-north-east to west-south-west in fair numbers. 13.45 hrs."

Mr. Brinsley subsequently supplemented the above at my request with the following notes :—

" It would be reasonable to assume that the migration continued while the sun was up, varying almost directly with the humidity and usually as the temperature.

" On 20th and 21st it would be fair to assume that the migration continued. My impression is that between the first and last dates given the migration was more or less continuous, though pressure of work hindered observations on many days.

" On 28th July the same Brown butterflies were migrating. There is no reason for assuming that the migration did not continue from between Lou Lou Island and, say, Calf Island."

The Brown butterfly referred to above is a Hesperid *Lignyostola crinisus*, Cram.,* while the White and Yellow butterflies are probably *Appias drusilla* and *C. sennae* and other species, although it is possible that the " White " butterflies may have been *C. statira*.

(7) From July 20th to 28th the writer was in the North-Western District, and observed the Hesperid, *Lignyostola crinisus*, Cram., migrating at Mabaruma on the 23rd, 26th and 27th. The migration was first observed about 1.30 p.m. on the 23rd, when a number of small butterflies were noticed flying at a good speed across the Government Compound at a height of from 25 to 30 feet. They were obviously migrating and were coming from across the valley, flying before the wind. After much difficulty three specimens were obtained, all of which proved to be Skippers with a peculiar brownish-yellow coloration on the wings and were unknown to me. The insects migrating all appeared to be of this species and exhibited the characteristic jerky and erratic flight of the Hesperids. The migration continued distinctly until about 5 p.m., but ceased shortly after. The direction of the flight and of the wind apparently remained the same throughout this period with but occasional slight variations. Heavy black clouds were noticed on the hills across the valley in the direction from which the insects came when the migration was first observed, but these cleared away later in the afternoon.

* Determined by Mr. G. E. Bryant, through the Imperial Bureau of Entomology.

On the 26th about 4 p.m. the insects were again observed migrating at Mabaruma Compound, but when they started or stopped cannot be said. On the 27th they were again observed migrating between 3.30–4 p.m. The direction of the migration on each occasion was from east-north-east and east to west-south-west and west, the direction of the wind was from north-east to east.

The above observations are the first records of Hesperids migrating in British Guiana as far as I am aware.

Early in August a collector brought in a collection which was made in July at Amsterdam, on the Demerara River, which is about 52 miles from the mouth, and amongst the insects was a single specimen of this Hesperid. He could give no information, however, with regard to its capture.

(8) Since the above was written, Mr. John Ogilvie has given me the following observations on a migration of *L. crinisus* which he witnessed on the Essequibo River on 1st June, 1929. Two specimens (one male, one female) of the insects were secured, and these have been deposited in the collection of the Entomological Division of the Department of Agriculture, British Guiana.

" On 1st June, 1929, while returning from a visit to the Kaieteur Fall, Mr. Ogilvie observed the butterflies migrating on the Essequibo River. Mr. Ogilvie is unable to say definitely when the migration started, but they were in noticeable numbers at a point on the river above Omai (in the vicinity of Kumaku Creek and Rapids) about 10 a.m. They were, however, not numerous at this point. He made definite observations between 1 p.m. and 3 p.m., during which time the insects were crossing the river literally in thousands. The general direction of flight was taken as from west to east, at the time he had no compass so could not give it more accurately, but since his return to town he has verified the direction and is of the opinion that it was N.W. to S.E. Mr. Ogilvie says that the direction of flight was also taken in relation to the course of the sun and thinks it may be described best in this relation as a few degrees north of the course of the sun.

" The migration ceased shortly before reaching Gluck Island —possibly due to a rain-shower which came shortly before and which lasted about 10 to 15 minutes, during which the number of insects migrating reduced considerably. The day was on the whole calm, but what wind there was was from the N.E., this being especially noticeable when the rain came on. The majority of the insects were flying about 15 to 30 feet above river level, a few as low as 10 feet. The butterflies were travelling quickly, but Mr. Ogilvie does not think their speed exceeded 30 m.p.h. As to the number of butterflies and the density of the swarm Mr. Ogilvie stated that if the butterflies had been the usual white ones (Pierids) it would have been like a snowstorm. Through a space in the roof of the launch about 3 feet long by 1 foot wide Mr. Ogilvie observed the number of butterflies passing over the launch and made counts at intervals against his watch, between 110 to 130 butterflies per minute were thus counted crossing this space, and so passing over the launch. There was no difficulty in observing the insects, as in this manner they showed up distinctly against the sky. Mr. Ogilvie further states that the migration was densest between a point on the river about Kurakura Pt. and Plantain Is. The weather during the previous week, Mr. Ogilvie informs me, was pretty rainy and the river was at the time in high flood."

All the localities mentioned are between Rockstone and the junction of the Essequibo and Potaro Rivers.

(9) Mr. H. W. B. Moore in the *Daily Argosy* for October 6, 1927, records another migration which occurred in the County of Berbice. He writes :—

" Near midday on Monday 19th of last month (September) thousands upon thousands of our common white Pierid began passing over the residential compound of the Albion plantation. They were on one of their periodic migrating flights. . . . The day was sultry and rather lowery with a moderate breeze from the east, and the butterflies were travelling in an east-south-easterly direction, that is obliquely against the wind, as is their custom. . . . They mounted over the roofs and then fell to their customary flight level, which is one to three feet above the ground, and it may be remarked that the stronger the wind the closer to the ground they keep. . . . From a distance they presented the appearance of a flutter of bits of white paper, as most of them were males, the females being of a more or less dirty or dusty white."

The species referred to is probably *Appias drusilla*, Cram.

(10) On 29th September Mr. Brinsley wrote me saying that he had " noticed a number of Pierid butterflies about; but not enough flying in one direction to constitute a migration. The insects were flying from north-east to south-west with the wind, but seemed to stop at The Settlement."

Mr. Brinsley was at the time stationed at His Majesty's Penal Settlement, Mazaruni. His observation is interesting when considered with Mr. Pearson's remarks, given later (No. 12).

(11) On 5th October, Mr. Brinsley wrote again: " White Pierid butterflies were observed on migration from east to west at Macowria on 1.x.27; weather fine, calm and clear, no wind; time about 11 p.m."

Whether the " White " Pierids were *A. drusilla* of course cannot be said. It is interesting to note, however, the closeness of dates between these observations and the one by Mr. H. W. B. Moore given above. If the same species was not involved, it at least points to migrations occurring in different parts of the Colony about the same date as was the case with the Hesperid *Lignyostola crinisus*, Cram., given previously.

(12) Mr. Brinsley recently sent me another observation of a migration under the date of September 13, 1928. He wrote :—

" Small pale yellow Pierid butterfly observed migrating west to east near Saxicalli in large numbers.

" White, deep orange and the above are very common at this season in the Essequibo River. The white in particular may be observed flying in strings of about 6 to 12, follow-my-leader fashion."

This seemed to be another composite migration apparently composed of the species *Catopsilia sennae*; *C. statira* (small pale yellow); *Appias drusilla* (whites) and *C. philea* (deep orange).

The following observations although not actually migrations bear close relation to them and are therefore included.

Daily Movements of Butterflies at Kartabo.

(13) During the months of July and August, 1926, a party of students under the charge of Mr. Jay F. Pearson of the University of Pittsburg were encamped at Kartabo, Mazaruni River, and after obtaining a record of the migration observed by Mr. S. Bracewell (No. 5), and hearing that there had been other migrations in the district about the same time, I wrote Mr. Pearson asking him if he had observed these, and for any data that he might have relative to them. In reply to my inquiries, Mr. Pearson wrote me under date August 3, as follows :—

" As Dr. Emerson has doubtless told you, there is an almost constant movement of butterflies from the north shore of the Cuyuni River to the

south shore, and from the north shore to the south shore of the Mazaruni. Such movements can be seen daily but are not true migrations that can be recorded as such."

Later Mr. Pearson supplemented the above observations in conversation with me, and a summary of his remarks are :—Flights occur daily, between 10 a.m. and 2 p.m. and are probably at their height about 12 noon. Prevailing wind is usually *up* river, but occasionally is the reverse. Flight will therefore be across the prevailing wind. The butterflies are to be seen crossing the Cuyuni River and also back of the Station, but do not get down as far as the cleaned area of the Penal Settlement. Whether this occurs all the year round he could not say, but certainly it was a daily occurrence during his stay at Kartabo. The butterflies were, in fact, as plentiful on the day he left Kartabo as on any day during the period he was there.

Mr. Pearson was at Kartabo from July 22 to August 15, and on the latter date made a collection of some of the butterflies which he gave to me. Of six specimens collected on August 15, four were *C. statira*, 3 ♂ and 1 ♀, and one *C. philea* ♂, the other insect being a *Cydimon leilus*. There is one other specimen he collected at Kartabo, dated August 8.

Reversal of Flight.

(14) Mr. E. E. Winter gave the following observation of a reversal of flight, a feature not often observed.

" R. Corentyne, August 19, 1920. Between Manakobi Creek down to Potoko Creek covering a bend of river about 5 miles. Potoko Creek marks the end of the sand and clay deposits that includes the cliffs of Orealla and Ipira (Epira). From Potoko to Manakobi is a vast swamp in which are growing trees of about 50 feet in height, palms of different species being predominant. On the Dutch side is flat clay land raised above the level of the river and carrying the ordinary riverside growths of Mora and other hardwoods.

" About 8 o'clock the butterflies were first observed crossing the river from the swamp on the Dutch side. There were countless numbers of the insects, so much so that when looked at horizontally through a pair of binoculars it looked for all the world as if a heavy snowstorm was raging."

Mr. Winter says that at the time he estimated that there were about 15 insects to the square yard.

The insects continued to cross in this direction until 11 a.m., but from this time until 2.30 p.m. Mr. Winter can give no definite information as to the direction of the flight, as he was in the forest during this period. About 3 p.m., however, at which time he was about a mile from Potoko, it was observed that the insects had reversed their flight and were making their way back from the British shore, and to the swamp from which they started in the morning.

Food-plant of Butterflies.

(15) The following description of the presence of large number of caterpillars said to be those of the Yellow and White butterflies appears in the " Report on the Work of the Boundary Commission from September, 1903 (British Guiana), by H. I. Perkins, I.S.O., F.R.G.S., M.I.M.M.,* pp. 5 and 6.

" Mr. Anderson reported to me that on the 11th October, about 3 p.m., a very violent squall struck the camp at Arakabisci, causing them all to get out of their tents under the trees and take to the clearing. Huge trees were falling

* Sessional Paper No. 265, Combined Court, British Guiana, 1905.

in every direction, and great branches were being snapped off by the force of the storm. The view within two miles up the Cuyuni from the camp was impressive in the extreme, as tree after tree, torn down by the wind, fell with a thunderous splash in the river. Torrents of rain fell, but fortunately no harm was done to anybody nor to the instruments. During the whole of their stay at Akarabisci, from the 4th to the 16th, the party experienced quite a plague of caterpillars that fell from the mora * trees on the young leaves of which they were feeding on the camp beneath, where they swarmed on everything, rendering it necessary to employ two boathands all day picking them up and destroying them. I had noticed the same phenomena at my camp on the way to Arawai. All night long there was a constant rain of them dropping on the tarpaulin stretched over my hammock, and in the morning it looked almost black from the same cause. The Indians call the caterpillars 'laliwa,' † and say that they are the larvae of the yellow and orange and white butterflies that we saw afterwards in countless numbers on the Cuyuni and Wenamu Rivers."

Swarming of *Catopsilia* on Flowers.

(16) Another observation by Mr. E. E. Winter was on the swarming of butterflies (? *Catopsilia statira*) on a particular kind of flower, of which unfortunately he cannot give the name. His observation is as follows :—

"Between Cow Falls and Little Timehri, River Courantyne, 22–23 July, 1920. On these days while going up the river, large numbers of butterflies were observed clustering on the flowers of a small tree which was frequently found along the river. The trees remain in flower for only a few days, and during that period the butterflies were invariably seen clustering on them."

The flowers Mr. Winter described as encircling the stems, after the manner of a bottle-brush, but covering a considerable length of stem, often as much as four feet; the flowers themselves were of a creamy-white colour; in fact, said Mr. Winter, of the same colour as the butterflies (? *C. statira*), and when the insect settled on them they were difficult to detect even at a distance of six feet. It was only when the boat came in contact with the branches of the tree on which they were clustered that they took flight and were noticeable. As soon as the boat had gone a few feet the insects immediately settled on the same or an adjacent branch.

Swarming of *Appias.*

On March 7, 1927, while on my way to New Amsterdam by train I observed the butterflies *Appias drusilla* to be swarming at places along the railway line. The insects were only observed in the County of Berbice, being seen first near

* *Dimophandra mora* (Nat. Order Leguminosae).

† Mr. Chapelle, Forest Ranger stationed at Pomeroon, who is himself a pure Arawak Indian, gave me the following notes :—

"These insects are called 'laliwa' in Arawak. The *yellow butterfly* larvae are known amongst the Indians of the Pomeroon (Arawak) to feed on young mora leaves. The mora tree renews its leaves and then flowers (in a few weeks), and it is after the flowering period that the migrations are observed. The mora sheds its leaves and renews them at the same time during the dry weather and drops its fruit just before the beginning of the long wet season—March to May. The caterpillars are to be observed during the flowering period, and migrations take place subsequently. The butterflies may frequently be seen flying from the mora trees to the sand banks or sandy areas in the river or coast. 'Saurama' Parrots, *Amazona farinosa* (Bodd), feed upon the caterpillars. Mora grows on swamp lands—clay flats—bordering streams or rivers."

The name Mora it has recently been found is applied to a number of trees of the genus *Dimophandra*, and the name "Morabukea" is given to one of these, probably *D. gongrijpii*, which grows on hilly ground.

Lichfield, which is about fifteen miles west of the Berbice River, and were also noticed at other points along the route until the termi us Rosignol on the Berbice River was reached. On the 9th, when returning, these butterflies were still present in numbers along the railway-line, between Rosignol and Belladrum, a distance of twenty miles.

Some days later, under date of 14th March, Mr. Seerkissoon, Laboratory Assistant in the Entomological Laboratory of Plantation Blairmont, sent me some of these insects with a note saying that the insects were swarming about that place "in hundreds" flying from a north-easterly to a south-westerly direction. Ten specimens were sent in, all of which proved to be *Appias drusilla* in the proportion of 8 ♂♂, 2 ♀♀.

Mr. Seerkissoon in his note gave the proportion of sexes 20 ♀♀ to 80 ♂♂, and the speed of their flight to be 6 to 8 miles per hour.

Summary.

In the foregoing account further observations on migrations of butterflies are recorded, as well as observations in related phenomena such as the swarming of the insects, reversal of flight, and notes with regard to the alleged food-plant of the larvae.

The observations concern principally Pierid butterflies, and the species recorded are *Catopsilia sennae*, L., under which name is included records attributed to *Callidryas eubule*, L.; *C. statira*, Cram.; *C. philea*, L.; *C. agarithe*, Bdv.; and *Appias drusilla*, Cram. Other species and families have also been observed migrating, and these are *Cydimon leilus*, L. (Uraniidae), *Coea cadmus*, Cram. (Nymphalidae), *Selenophanes cassiope*, Cram. (Nymphalidae) and *Lignyostola crinisus*, Cram. (Hesperidae).

Such migrations may comprise only one species, but may, and indeed often do, embrace several species. In one such migration now recorded eight species were involved.

As to the time of year such migrations occur, it may be said that they principally take place between July and October, or after the long wet season. Migrations have been recorded as early as March (*Trans. Ent. Soc.*, 1921), and of the observations given now at least a swarming of *Appias drusilla* was observed in March; there may be, therefore, another migration period following the short wet season in the early part of the year.

The most complete record in the above observations is that of the large migration which occurred in July 1926. This migration continued in a more or less distinct manner for about three weeks, and included at least seven species of butterflies as well as the moth *Cydimon leilus*. The area of country over which the migrations occurred is also remarkable, the insects being observed in various places over an area of about 1,000 square miles during a period of twenty-three days.

Two records of migrations of the Hesperid *Lignyostola crinisus*, Cram., occurred in July 1927, at widely separate points. This is the first record of a Hesperid migrating in British Guiana as far as I am aware.

Migrations of "whites" are also recorded as occurring during the month of October 1927, in Berbice (No. 9) and on the Essequibo River (No. 6).

The occurrence of migrations such as the above at widely separated points on the same or closely occurring dates, as well as migrations occurring over a vast area, would seem to indicate either, that such migrations traverse a large area of country, or, what is perhaps more probable, that independent migrations occur in different parts of the Colony at the same time of the year.

THE GEOMETRIDAE OF THE "ST. GEORGE" EXPEDITION FROM FRENCH OCEANIA

By Louis B. Prout.

[Read October 2nd, 1929.]

The localities dealt with in the present paper are those enumerated by Mr. C. L. Collenette in Vol. LXXVI of the *Transactions of the Entomological Society of London*, Part II, p. 469, and the bibliographical references which he there gives should again be used, together with a very valuable zoogeographical discussion by Mr. Edward Meyrick, on pp. 489–91 of the same publication, in which he suggests employing the name of Palaeonesia for the hypothetical land area which seems to offer the only intelligible explanation of the general faunistic homogeneity of these islands, now so widely sundered.

The Geometridae of the region, as the following list will show, are by no means rich in species, and it is scarcely an exaggeration to say that the collections are made up almost entirely of the three genera *Chloroclystis*, *Gymnoscelis* and *Cleora*. Some notes on the composition and distribution of these genera have been given by the present writer in the *Insects of Samoa*, Brit. Mus. (Nat. Hist.), Part iii, Fasc. 3 (1928), and as no important additions have since been made it is unnecessary to give any similar exposition here. The same, indeed, applies also to the few other genera which are represented—*Thalassodes*, *Anisodes* and *Scopula*. A closer study of the Tahitian *Cerotricha*, to which brief reference was made on pp. 154–5 of that work, has increased the doubts which were then suggested as to the validity of the genus. Assuming it to be an aberrant member of *Cleora*, the last-named will remain the sole genus of the huge subfamily Geometrinae known from the remoter islands of the Pacific, unless another generic position can be found for an ambiguous Nuka Hiva ♀ described below.

Subfam. Hemitheinae.

1. **Thalassodes pilaria,** Guén.

Thalassodes pilaria, Guen., Spec. Gén. Lép., ix, p. 361, pl. 15, fig. 2 (1858) (Tahiti).

Society Islands: Tahiti, 1 ♀ at light on ship in harbour, Papeete, 18.ii.25; 4 ♀♀ at light, 1500 feet, Fautaua, 16.iii.25. N.E. Raiatea, 1 ♂, 1 ♀, sea-level, 15.v.25; 1 ♀, 26.v.25 (*Miss L. E. Cheesman*). Bora Bora: Vaitape, 1 ♂ at light, 21.vi.25 (*Miss L. E. Cheesman*).

For the distribution see *Ins. Samoa*, Brit. Mus. (Nat. Hist.), iii (3), p. 121 (1928).

Subfam. Sterrhinae.

2. **Anisodes (Brachycola) decolorata,** Warr.

Brachycola decolorata, Warr., Nov. Zool., **4**: 215 (1897) (Lifu, Loyalty Is.).

Society Islands: Tahiti, 2 ♂♂ at light, Papeete, 24.ii.25.

Tuamotus: Fakarava, 1 ♂ at light, 12.ii.25.

The above three specimens appear to agree well together and may be provisionally referred to *A. decolorata*, though the apex of the fore-wing and the midtermen of both wings may perhaps be slightly less prominent, and the

coloration is more as in *niveopuncta*, Warr. (1897) and its race (?) *matthias*, Prout (1925). Probably all are forms of a single species, but little Pacific material is yet known, and none perfect; while the very close likeness of their two Indian representatives—*absconditaria*, Walk. (1862), and *clandestina*, Prout (1918)—both to one another and to *niveopuncta*, Warr., all the three being distinguishable structurally, shows that much care will be needed in determining the status of the rest. The *decolorata* group is already known from India, the Malay Peninsula, the Greater Sunda Islands, Celebes, Ceram, New Guinea, Queensland, the Bismarck Archipelago and Fiji, the form from the last-named islands being apparently *decolorata*.

3. **Anisodes (Xenoprora) samoana** (Warr.).

Brachycola samoana, Warr., Nov. Zool., **4**: 216 (1897) (Upolu).
Anisodes (*Xenoprora*) *samoana*, Prout, Ins. Samoa, Brit. Mus. (Nat. Hist.), iii (3), p. 125 (1928).

This species, which I have discussed at some length in the *Insects of Samoa*, was neither taken by the "St. George" Expedition nor by Miss Cheesman in her subsequent collecting on the Society Islands. Thus no further light is yet available on the two extremely worn Tahiti ♂♂ in the British Museum.

4. **Scopula oxystoma,** sp. n.

♂. 24–26 mm. Face and palpus black. Tongue short but stout. Antenna with fascicles of long cilia. Vertex pale. Collar ochreous. Thorax and abdomen rather less deep ochreous, paler beneath; abdomen on each segment with a black dorsal spot, those on 3, 4 and 5 largest. Fore leg partly blackened. Hind tibia slender, with a pair of well-developed terminal spurs (section *Pylarge*), tarsus long.

Fore-wing rather narrow, termen smooth, gently curved, strongly oblique; SC^1 from before (generally close to) end of areole, SC^5 very variably stalked with SC^{2-4}; cream-buff, clouded with a browner shade; some scattered black irroration, especially anteriorly; a rather large black cell-dot; lines ochreous; antemedian at one-third, oblique outward to SC, then oblique inward, incurved at fold; median excurved round cell-dot, very oblique inward to M^2, where it is closely approximated to antemedian, then rather less oblique to hind margin before middle; postmedian nearly parallel with median, but with a rather long and acute tooth outward at R^1 and with all the veins from SC^5 hindward marked with black dashes of varying size, that on R^1 generally the longest; subterminal crenulate anteriorly, incurved between M^2 and SM^2, enclosed between moderate shades; termen with sharp black dots; fringe unspotted.—*Hind-wing* not broad, termen only very slightly bent at R^3, close to tornus faintly concave, the tornus itself rather prominent, much as in the African *sublobata*, Warr. (1898); first line wanting; median nearly straight from SC to abdominal margin, proximal to cell-dot; postmedian with the black dashes obsolescent; this and the subterminals incurved opposite the cell; terminal dots as on fore-wing.

Underside sharply marked, with black cell-dots and terminal dots and blackish-fuscous median and postmedian lines, the median on hind-wing rather strongly angled at SC.

Marquesas: Hiva Oa, 3 ♂♂ at light, 3500 feet, 28.i.25.

A very interesting species, not closely related to any hitherto known. The members of the genus which have retained terminal spurs on the ♂ hind tibia number nearly 50 (about 10 per cent.), mostly Palaearctic and African, but with a few in North America, one in Colombia, two or three in India and some half-dozen in Australia. As they are no doubt merely survivals from a less specialised condition, it is not surprising that they are not all homogeneous among themselves.

5. **Scopula tersicallis,** sp. n.

♂. 24 mm.; ♀, 28 mm. Possibly related to the preceding, with which it nearly agrees in shape (though the fore-wing is rather more acute, with rather straighter termen), venation, extremely angulated postmedian and a few other points; but it has much more of the facies and coloration of some of the already-known *Pylarge* (*e.g.*—to judge from the description—*loxosema*, Turn., *Proc. Linn. Soc. N. Sth. Wales*, 32 : 669, Victoria), and has a weakly marked underside, and has more likely had a quite independent origin; very unfortunately the hindlegs and abdomen are lost in the only ♂.

Face and palpus black; tongue moderate. Antennal fascicles little longer than diameter of shaft. Vertex pale. Thorax and abdomen concolorous with wings. Fore leg not black-mixed.

Fore-wing very light drab or drab-grey, somewhat clouded and with some scattered blackish irroration, leaving a strikingly clear band between median and postmedian; lines rather weak, highly oblique; antemedian quite indistinct, but marked in the ♀♀ by a dark spot on *M* (at base of M^2) and one on SM^2; median nearly straight from middle of hind margin to R^1 about 2·5 or 3 mm. from termen, here acutely angled but becoming almost obsolete; postmedian shortly beyond it, marked with a dark stroke from hind margin to SM^2 and with dots or very short dashes on the other veins, very acutely angled at R^1; subterminal close to postmedian, clear and fairly broad, wavy, bounded distally by a weak and narrow shade; termen with small black dots; fringe pale.—*Hind-wing* with markings of fore-wing continued; cell-dot small, median line straight, almost touching its proximal side, the postmedian and to a lesser extent the subterminal somewhat incurved between the radials.

Fore-wing beneath glossy, with the markings, excepting a small blackish cell-dot, quite weak; hind-wing much paler, with cell-dot and terminal dots present, postmedian line indicated or moderately developed, median sometimes traceable.

MARQUESAS: Hiva Oa, 1 ♂ (holotype) beaten from herbage, 3000–3500 feet, 27.i.25; 2 ♀♀ at light, 3500 feet, 28.i.25.

Subfam. LARENTIINAE.

6. **Chloroclystis lepta** (Meyr.).

Pasiphila lepta, Meyr., Trans. Ent. Soc. Lond., **1886**: 191 (1886) (Marshall Islands).

SOCIETY ISLANDS: Tahiti, 1 ♂ at light on ship in harbour, Papeete, 18.ii.25. Moorea, Orofaga Bay, 1.ii.13 (*C. S. Betton*), 1 ♀ in Mus. Brit., recorded in *Ins. Samoa*, Brit. Mus. (Nat. Hist.), iii (3), p. 137, where a note is given regarding the few known specimens of the species. Closer study, however, has raised grave doubts as to the determination of the Tonga ♀ (the assumed allotype), with its smooth, even markings, especially the very regular, uninterrupted and nowhere strengthened subterminal band. The other examples are not very fresh, but the two from the Society Islands suggest transitions between the type and the following species.

7. **Chloroclystis torninubis,** sp. n.

♂♀. 13–17 mm. Face pale, tinged with green, lower part more brownish. Palpus 2; 2nd joint heavily and rather evenly scaled, 3rd joint distinct; pale, with a blackish spot on outerside of 1st joint and a more or less developed line of dark scales on underside of 2nd. Antenna with the slightly erect scales at ends of joints blackish; ciliation in ♂ less than ½. Thorax above dark-mixed; abdomen with tergite 2 dark or blackish. Fore

tibia and fore and middle tarsi banded; hind tibia with the inner spurs long, the outer short.

Fore-wing moderate or rather narrow, the sexes alike; termen very gently curved, moderately oblique; delicate green, costally perhaps more ochreous, the whole easily discolouring to light ochreous brownish; markings generally heavy, blackish-fuscous, the cloudings of the outer area generally more inclining to warm blackish brown or dark livid brown; basal patch very small; antemedian band-like anteriorly, slenderer and weaker posteriorly, irregular and rather variable; postmedian thick or band-like, generally of equal width and intensity throughout, slightly oblique outward from costa, with two very blunt teeth or angles (behind R^1 and behind R^3), posteriorly nearly parallel with termen or slightly incurved; subterminal line white, rather irregularly dentate, rarely conspicuous, but accompanied by dark clouds costally (especially proximally) and between the radials, and with a large, generally highly developed tornal cloud which reaches the postmedian; terminal line fairly thick, interrupted by small pale dots at the veins; fringe with large dark spots opposite the veins.—*Hind-wing* with termen smooth, between R^1 and M^1 scarcely convex, hence appearing rather full about M^1, near tornus very faintly sinuate; SC^2 separate; less green than fore-wing, excepting a rather clear green band between the postmedian and the proximal subterminal shade and generally an outer dash or spot projecting from this band to termen between R^3 and M^1; postmedian thick, with a moderate projection just behind middle accentuated by an inward posterior curve; proximal part of wing traversed by more or less strong lines.

Underside glossy light drab, rather paler (more mixed with whitish) on hind-wing and especially at hind margin of fore-wing; postmedian line (band) well expressed, distally pale-edged.

Marquesas: Hiva Oa, 11 ♂♂, 22 ♀♀ (the typical series) at light at 3500 feet, 28.i.25; 1 ♂ at light at 1100 feet, 13.i.25; 8 ♂♂, 14 ♀♀ at light near sea-level, 26–30.xii.24. Tahuata, 6 ♂♂, 3 ♀♀ at light, 500–850 feet, 10–13.i.25.

Probably essentially a mountain species, as is indicated not only by its abundance on the single night when the high altitude was worked, but also by the fact that this series is on an average larger and more sharply marked than the rest.

Variable; three of the ♀♀ (two from 3500 feet, one near sea-level) are of an aberration with the entire median area of the fore-wing darkened into a band. The anterior dark marking of the abdomen is not rarely extended.

I have described this species independently, but am not certain that it may not be a heavily marked race of the little-known *lepta*, Meyr., although the palpus appears very slightly less long. In any case it is closely related. Specimens which have lost the hind legs can be quite easily separated from similarly clouded aberrations of *Gymnoscelis imparatilis* (Walk.) by the heavier, less black-spotted palpus, absence of black spots on sides of face, less narrow wings (notably in the ♂) and more posteriorly placed angle of the postmedian of the hind-wing.

8. **Chloroclystis coloptila**, sp. n.

♂♀. 13–17 mm. Face without cone; a bluntly V-shaped fuscous-black mark developed or indicated. Palpus nearly 2 in the ♂, rather longer in the ♀; second joint beneath with long-projecting scales, which are marked with blackish on outerside, pale beneath; first joint also with a black patch on outerside. Antenna in ♂ rather thick, tapering distally; ciliation not quite ½. Hind tibia with the inner of each pair of spurs long. Abdomen with a more or less strongly darkened belt on tergite 2; beneath pale; ♀ ovipositor exserted.

Fore-wing in ♂ with costa shouldered near base, then straight, apex strongly truncate, so that the termen is oblique outward from the rounded tip to a strongly rounded gib-

bosity at the radials; in ♀ normally shaped; drab, with darker lines, which mostly become fuscous-black costally and are slightly connected by faint shades so as to form the normal pattern of the genus; a slender but very conspicuous band of the pale ground-colour cuts the median area proximally to its middle, forming a very slight outward curve and touching or crossing the base of M^2; postmedian line lunulate-dentate, with the usual indentation between R^1 and R^3, otherwise nearly parallel with the termen, thus more strongly excurved in the ♂ than in the ♀; narrow pale band outside the postmedian rather sharply divided except near hind margin; subterminal line distinct, slender, dentate anteriorly, sinuate posteriorly; terminal line relatively thick but not intense, broken by pale spots at veins; fringe with a pale line at base and pale tips.—*Hind-wing* with termen almost inappreciably excised near tornus; SC^2 well separate; markings similar to those of fore-wing, the postmedian and band beyond inbent at M^2.

Underside notably paler on hind-wing and behind cell and M^2 of fore-wing; indications of the principal markings, especially on the fore-wing anteriorly; fringe mostly pale.

Marquesas: Nuka Hiva, 4 ♀♀ at light, 200 feet, 16.i.25; 1 ♀ at light, near sea-level, 21.i.25; 2 ♀♀ at light, 300 feet, 22.i.25; 3 ♂♂ (including holotype), 5 ♀♀ at light, near sea-level, 23.i.25; 2 ♂♂, 8 ♀♀ (including allotype) at light, 300 feet, 24.i.25. Hiva Oa, 6 ♀♀ at light, 26.xii. 24; 1 ♂ at light, 27.xii.24; 3 ♂♂, 11 ♀♀ at light, 28.xii.24; 1 ♀ at light, 29.xii.24; 1 ♂, 2 ♀♀ at light, 30.xii.24; 1 ♀ at light, 1200 feet, 3.i.25.

9. **Chloroclystis,** sp.

Tuamotus: Fakarava, 2 ♀♀ at light, 12.ii.25.

Both are more or less worn and both have unfortunately lost the head. So far as can be made out, they look a good deal like the smallest ♀♀ of the preceding species, with which they agree in venation, and to which, or even to *lepta*, Meyr., they may easily belong. The less bad specimen, however, appears to show stronger costal spots at the origin of the principal lines than is characteristic of either of these species and the possibility is not excluded that they may belong to a member of the subgenus *Bosara*, Walk. (1866). It is not even absolutely certain that the two are conspecific; for the more worn example does not show an appreciable concavity in the termen of the hind-wing between M^1 and tornus, while this concavity is very manifest in the other and this latter had perhaps, when fresh, more of the coloration of *torninubis*, Prout.

10. **Chloroclystis ambundata,** sp. n.

♀. 19 mm. Face rounded-prominent, apparently without cone. Palpus 1½, second joint with shortly projecting scales beneath, terminal joint quite small. Antenna slender, with very short ciliation (scarcely over ⅓), the single bristles rather short; whitish, with dark rings. Head and body whitish grey, somewhat clouded and with slight olive-brown irroration, beneath whiter; abdomen stout, crests vestigial, ovipositor exserted. Fore tibia and tarsus infuscated, with whitish spots at ends of joints; the other tarsi also more or less dark-marked; hind tibia with all spurs well developed, the inner ones rather long.

Fore-wings of medium width, costa straight from near base to near apex, apex round-pointed, termen curved, rather strongly oblique; white, slightly irrorated with olive-brown and traversed by olive-brown wavy lines and bands; basal patch apparently straight, succeeded by two or three fine lines (both examples here somewhat rubbed); a band-like antemedian, two subparallel lines less than 1 mm. apart being connected—at least in anterior part—by dark shading, the distal of them outbent in anterior part of cell, the promixal here more gently curved; a narrow (1 mm. or less) postmedian band at about

two-fifths, starting at right angles with costa or scarcely oblique outward, bluntly bent about R^1, somewhat thickened between this and M^1 and again about SM^2, slightly outbent at these veins and incurved between; the pale median area bisected by a line, the postmedian band succeeded distally by another line; proximal subterminal shading strengthened into small blotches at the radials and tornus, distal shading vaguely macular throughout; terminal line slightly interrupted at the veins; fringe mostly brown, with white spots opposite the veins.—*Hind-wing* with apex and termen rounded, the latter rather fully about SC^2 and R^1, becoming straighter behind M^1, slightly prominent at tornus; SC^2–R^1 shortly stalked; concolorous with fore-wing, the irroration rather strong costally and distally, and especially about apex; the lines mostly thick, but none band-like.

Underside reproducing the pattern of upper, though more weakly.

Marquesas: Hiva Oa, 1 ♀ (holotype) beaten from herbage, 28.xii.24, 1 ♀ (paratype, more suffused) taken at light, 26.xii.24.

Quite separate from the four preceding species, which are nearly related in the hind-wing venation and (unless possibly No. 9) in the palpus. I am unable to suggest any species or group in *Chloroclystis* with which it may be particularly associated, but rather suspect that the ♂ will show some specialisations, perhaps adding another to the numerous subgenera which are already recognised.

11. **Gymnoscelis imparatilis** (Walk.).

Botys imparatilis, Walk., List Lep. Ins., xxxiv, p. 1416 (1865) (Sarawak).
? *Eupithecia indicata*, Walk., List Lep. Ins., xxxv, p. 1675 (1866) (Sarawak).
? *Eupithecia confusata*, Walk., List Lep. Ins., xxxv, p. 1676 (1866) (Sarawak).
? *Eupithecia subtristigera*, Walk., List Lep. Ins., xxxv, p. 1679 (1866) (Sarawak).
? *Gymnoscelis grisea*, Warr., Nov. Zool., **4**: 229 (1897) (Fergusson I.).
Gymnoscelis perangusta, Warr., Nov. Zool., **4**: 229 (1897) (Borneo); Hmpsn. J. Bombay Nat. Hist. Soc., **18**: 48 (1907) (Marquesas).
Gymnoscelis delocyma, Turn., Proc. Roy. Soc. Vict., **16**: 226 (1904) (N. Queensland).
? *Gymnoscelis upolensis*, Rbl., 2 Beih. Jahrb. hamb. wiss. Anst., **32**: 131 (1915) (Upolu).
Gymnoscelis imparatilis, Prout, Ins. Samoa, Brit. Mus. (Nat. Hist.), iii (3), p. 142 (1928) (Penang, Borneo, ? Moluccas).

Marquesas: Hiva Oa, 1 ♂ at light, 30.xii.24. Nuka Hiva, 2 ♂♂, 2 ♀♀ (*J. J. Walker*) in coll. Brit. Mus.; 6 ♀♀ at light, 300 feet, 22.i.25.

Society Islands: Tahiti, Papeete, 2 ♀♀ beaten from herbage, 20 and 22.ii.25; 2 ♂♂ at light on ship in harbour, 21 and 23.ii.25; 1 ♂ at light near sea-level, 27.ii.25; 8 ♂♂, 11 ♀♀ at light, 300 feet, 4.iii.25; 1 ♂ beaten from herbage, 5.iii.25; 1 ♂ at light, 18.iii.25; 1 ♂ near Papeete, iii.–iv.25 (*Miss L. E. Cheesman*). N. E. Raiatea, 2 ♀♀ at sea-level, 16.v.25; 1 ♀, 17.v.25; 1 ♀, 20.v.25 (*Miss L. E. Cheesman*).

The extensive and evidently variable series from Tahiti, though mostly in extremely poor condition, should prove of value in helping to elucidate the difficult group of forms cited under the above synonymy. Repeated and prolonged study of the series has not revealed the slightest ground for suspecting any mixture of species; yet it contains purpler and browner, weakly marked and strongly marked examples and in particular shows much variation in the distal area. Some of the forms are so closely like some from Borneo, and indeed from N. India, that I am not prepared to point out even racial distinctions, unless possibly the antennal ciliation be very slightly less rudimentary in the Polynesian forms—here appreciably over $\frac{1}{3}$, in the other forms apparently scarcely over $\frac{1}{3}$, though "$\frac{1}{4}$," given by Turner for *delocyma*, seems in any case an under-estimate.

Some of the ♀♀, as already noted under *Chloroclystis torninubis*, have a more or less strongly clouded tornal region of the fore-wing and closely resemble

a Cairns district ♀ which has stood in my collection as *aenictopa*, Turn. (1907), but which I now suppose to be an aberration of the species earlier described by the last-named author as *delocyma*. When in addition to the tornal cloud there is also an anterior darkening in the distal area, a pale central spot tends to develop which weakens the validity of my provisional differentiation of *G. indicata* (*Ins. Samoa*, Brit. Mus. (Nat. Hist.), iii (3), pp. 142, 143). The shape of the ♂♂ is fairly constant in Polynesia, but a part, at least, of the imagined differences among the Malayan is due to condition and other fortuitous circumstances. It should be stated here that the venational distinction between "11 anastomosing with 12" and "11 running into 12" is not entirely reliable. In most cases, at least in the Polynesian forms, *C* of the fore-wing, after a moderate anastomosis with SC^1, runs off weak or attenuated to or towards the costal margin, not rarely fading out before reaching it; in a few cases it is not traceable at all, so that the taxonomist would say, "SC^1 running into *C*." In my examples of *delocyma*, some of which are a part of Dodd's original bred series from Townsville, definite relics of the costal end of *C* persist, though apparently that was not the case in the specimens examined by Dr. Turner.

The four examples from Raiatea are all rather small, dusky and purplish and may possibly represent a local modification, although this is unlikely; they may be members of a single family or strain.

The "St. George" Expedition ♀ from Nuka Hiva mentioned in *Ins. Samoa*, iii, p. 142, under *upolensis* was captured on 22.i.25 and is included in the series enumerated above; it in no way differs from the others except that it is in better condition.

G. imparatilis is probably, like the genotype of *Gymnoscelis*, a general feeder and adaptable in its larval habits; yet it is not impossible that the diversified indications thus far available will later be found to afford clues to a differentiation of species. At Pusa it has been bred from flowers of *Cassia fistula*. At Kuala Lumpur larvae of the *subtristigera* form have been found boring in *Tabernaemontana* species. At Townsville the larvae (*delocyma*) fed on *Scyphiphora hydrophylacea*, "turning over and fastening down the young foliage and feeding under cover like a pyrale."

12. **Gymnoscelis erymna** (Meyr.).

Eupithecia erymna, ♂, Meyr., Trans. Ent. Soc. Lond., **1886**: 192 (1886) (Tonga).
Gymnoscelis concinna, Swinh., Trans. Ent. Soc. Lond., **1902**: 651 (1902) (Tonga).
? *Gymnoscelis semipurpurea*, Rbl., 2 Beih. Jahrb. hamb. wiss. Anst., **32**: 150 (1915) (Samoa).
Gymnoscelis erymna, Prout, Ins. Samoa, Brit. Mus. (Nat. Hist.), iii (3), p. 140 (1928).

Society Islands: Tahiti, 2 ♂♂ beaten from herbage, Papeete, 20 and 22.ii.25; 1 ♀ at light, Papeete, 300 feet, 4.iii.25; 2 ♂♂, 9 ♀♀ at light, Fautaua, 2500 feet, 13.iii.25. ? N.E. Raiatea, 1 ♂ at sea-level, 25.v.25 (*Miss L. E. Cheesman*).

Austral Islands: Rurutu, 1 ♂ at light, 650 feet, 23.iii.25; 2 ♀♀ at light, 400 feet, 24.iii.25.

Rapa Island: 1 ♀ at light, 14.iv.25; 1 ♂ at light, 800 feet, 15.iv.25; 1 ♂, 2 ♀♀ at light, 800 feet, 17.iv.25.

This species has been redescribed, and the hitherto known specimens catalogued or referred to, in the *Insects of Samoa* (*loc. cit. supra*). The "St. George" Expedition has added materially to our knowledge of its range, which is now seen to cover a considerable part of Palaeonesia, although the Marquesas have still failed to yield it. From the Tuamotus it will be noticed

that only two Geometrid species were obtained, *Anisodes decolorata* and the doubtful *Chloroclystis* (No. 9, *supra*).

The ♂ from Raiatea is badly damaged and appears too slender and narrow-winged for *G. erymna*, at first sight strongly suggesting *G. imparatilis*. The structure, however (longer antennal ciliation and wide separation of SC^1 from C on the fore-wing), gives a definite clue to the determination and the form of the postmedian line, so far as it can be made out, supports it. The only alternative would be to suppose it an otherwise unknown species.

The specimens from Rapa Island are on the whole large and rather sharply marked, conceivably a geographical race.

Subfam. Geometrinae.

13. **Cleora stenoglypta**, sp. n.

♂. 43–44 mm.; ♀, 44–54 mm. Head rough-scaled, face shortly tufted below. Palpus 2, second joint rough-scaled above and below, third joint moderately strong and elongate. Antenna long (about 18 mm.); in ♂ pectinate to beyond two-thirds, the branches very long and lax, curling about the shaft, each surmounted by a bristle, the distal segments pubescent and with single bristles; in ♀ setose and minutely pubescent. Pectus and coxae densely hairy. Legs long; ♂ hind tibia strongly dilated, with hair-pencil, tarsus almost $\frac{3}{5}$. Abdomen elongate, but moderately robust, with slight lateral tufts; in the ♂ with the basal spine not long, but with the ridge of bristles of the 3rd sternite strongly developed; ovipositor in ♀ long, extruded. Head and body concolorous with wings, abdomen in ♀ with strong paired blackish spots beneath. Legs predominantly pale, dark-speckled.

Fore-wing with costa slightly arched near base and near apex, apex rather sharp, termen weakly crenulate, at R^3 almost inappreciably bent, to become more oblique; DC^3 deeply inbent, SC^1 and SC^2 from cell, well separate, the latter sometimes connected by a bar with SC^{3-4}; fovea in ♂ clothed with suberect scales above; variable; ground-colour in the ♀ warm buff, sometimes a little lighter; in the ♂ with more cinnamon suffusion, generally with nearly the whole wing more or less dark-clouded, excepting a band proximal to the subterminal; some blackish irroration; a slender, sinuous white cell-mark, neither reaching R^1 nor R^3, suffusedly bordered with blackish; ante- and postmedian lines marked by strong black vein-dots, the very fine, or subobsolete, grey connecting thread scarcely lunulate; antemedian strongly excurved in cell; postmedian approximately parallel with termen, only feebly sinuous, though somewhat variable; brown or blackish shades or bands (strong in ♂♂, weak in most ♀♀) proximal to the antemedian and distal to the postmedian; ill-defined basal markings; a strongly sinuous median line, excurved round the cell-spot; subterminal lunulate, filled-in proximally by more or less strong dark spots; terminal black dots between the veins; fringe dark-clouded.—*Hind-wing* with termen more deeply crenulate; proximal half very feebly marked; white cell-mark almost punctiform, median line generally crossing it; markings beyond as on fore-wing.

Underside more weakly marked, the white cell-marks standing out sharply, on both wings generally sinuous, in the ♀♀ and the lightest ♂ sharply black-edged.

Rapa Island: 1 ♀ at light, near sea-level, 14.iv.25; 1 ♂, ♀♀ (including allotype ♀) at light, 800 feet, 15.iv.25; 3 ♂♂ (including holotype) at light, 800 feet, 17.iv.25.

The holotype ♂, chosen on account of its unbroken antennae, is of the dark form; one less dark ♂ (17.iv.) and one ♀ which approaches the ♂ in coloration (15.iv.) have the bands very strong.

In its general scheme, and especially in the nature of the sex-dimorphism, with dark, clouded ♂♂ and clean buff ♀♀, this interesting species bears a

curiously close resemblance to *C. panagrata* (Walk.), from New Zealand. The connection is partly superficial, for the latter is an outlier, if not generically separable from *Cleora*, differing in its more slender build, relatively ampler wings, tuft on head between the antennae, etc. But in view of the distribution of the botanical genus *Corokia* (cf. *Trans. Soc. Lond.*, **74**: 269) it deserves notice. Almost certainly, however, *C. stenoglypta* derives from the same stock as *C.* (*Cerotricha*) *licornaria*, Guén., from which it differs chiefly in its larger size, robuster build, longer ovipositor, less extremely long antenna, longer hind tarsus of ♂, with first joint longer than second (in *licornaria* about equal), more shouldered costa of fore-wing and longer cells.

14. **Cleora dodonaeae**, sp. n.

♀. 40–46 mm. Distinguishable from *C. stenoglypta* (*supra*) as follows :—

Palpus with terminal joint less long, partly concealed by long projecting hair from second joint. Antenna with the setae rather slighter. Legs less long. Abdomen without the blackish ventral spots. Wings relatively a trifle less elongate; fore-wing with *DC* less deeply inangled, SC^1 and SC^2 more approximated, in the type and one other example short-stalked; ground-colour whitish; cell-marks larger, more typical of the genus, above formed of longitudinally directed, raised white scales, beneath on fore-wing large, dark, broad-oval; lines blacker, finely dentate, the postmedian rather deeply indented between SC^5 and R^1; terminal dots larger, in part connected by a fine line; underside with more or less developed terminal or subterminal band, fairly broad at the costal margin of the fore-wing (but leaving the apex clear white), tapering posteriorly, rarely continued at all distinctly on the hind-wing.

Rapa Island : 1 ♀ at light, 11.iv.25; 2 ♀♀ at light, 12.iv.25; 1 ♀ at light, 14.iv.25; 1 ♀ (the holotype, rather small) bred from larva, pupated 28.iv.25, emerged 20.v.25.

Probably near *myrmidonaria*, Guén. (*infra*), though so much larger.

Larvae were collected by Miss C. E. Longfield on 13.iv.25, and were feeding on *Dodonaea viscosa*, L., which grew on exposed grass-covered slopes on the hills. Unfortunately several starved owing to the withering of the food supply after the "St. George" had left the island, and the ♂ remains unknown. Three larvae in different stages were preserved. The adult larva is moderately stout, rugose, without prominences. Head rather large, moderately lobed, face rather flat, scarcely sloping, pale, much mottled with brown and blackish. Body subcylindrical, the segmentation and subsegmentation distinct; prothoracic plate undeveloped; spiracles large, oval, pale, black-rimmed; tubercles small, setae very short and inconspicuous; only the normal Geometrid prolegs present. Miss Longfield reports that the colour varies greatly in different larvae. Body bright grass-green, light brown, olive-brown or reddish-brown, with numerous faint longitudinal dark brown or black stripes. A white medio-dorsal stripe, strongly marked in young, usually almost invisible in fully grown larvae, and more distinct in the green than in the brown types of larvae. A broad dirty white or pinkish longitudinal stripe on underside of body, from first abdominal to sixth abdominal segment. Legs orange-red, prolegs of same colour as body. Head rich red-brown, the white medio-dorsal stripe sometimes encroaching on and ending at the top of the head.

The larva rests at an angle of 45 to 80 degrees from the food-plant, with the body generally slightly curved, and supported by a thread of silk. The green larvae were not easily seen on leaves nor the brown larvae on the twigs of the plant, but it was particularly noticed that neither type of larva appeared

to select resting places of its own colour. When disturbed, they fell at the end of a thread, and if held in the hand, sometimes wriggled and sometimes lay quiet in a rigid attitude.

Pupa rather smooth, polished, of about the same texture and brown-red coloration as that of the well-known European *Alcis rhomboidaria* (Schiff.); abdomen tapering relatively little from the 8th to the 10th segment, the latter being unusually blunt, with the narrow cremaster outstandingly differentiated (compare *Biston*, etc.), rather small, with the prongs about as long as their base; legs and antenna rather long.

15. **Cleora myrmidonaria** (Guén.).

Tephrosia myrmidonaria, Guen., Spec. Gén. Lép., ix, p. 271 (1858); Oberth., Études Lép., ix (1), fig. 1916, (1913) (Tahiti).

Society Islands: Tahiti, 1 ♀ at light, Fautaua, 2500 feet, 13.iii.25; 7 ♂♂, 1 ♀ at light, Fautaua, 1500 feet, 16.iii.25; 1 ♂ in Mus. Brit. (*J. J. Walker*).

This species was scarcely known except from Guénée's poor types. It is certainly a *Cleora* of the section with extremely long and lax, curled ♂ pectinations; fore-wing with SC^1 and SC^2 from cell, free; fovea in ♂ strong. Variable; the ♂♂ more brownish, sometimes sharply, sometimes more weakly and uniformly marked, one example with the median and postmedian broadened and largely confluent into a blackish-fuscous band; the ♀♀ whiter, especially the one from the higher altitude.

16. **Cleora collenettei,** Prout.

Cleora collenettei, Prout, Entomologist, **62**: 255. (1929) (Marquesas).

♂♀. 29–39 mm. Frontal cone strong. Palpus 2; second joint heavily scaled above and beneath, the projecting scaling partly concealing the third joint, which is somewhat drooping, moderate, scarcely longer or more clavate in the ♂ than in the ♀. Antenna long, in the ♂ fully two-thirds the length of fore-wing, the pectinations extremely long and lax, curling about the shaft, both shaft and pectinations clothed with long ciliation, the apical one-fifth or one-fourth merely ciliated. Hind tibia in ♂ strongly dilated, with hair-pencil, proximal spurs very unequal, terminals both short; hind tarsus in ♂ $\frac{3}{8}$ or scarcely. Ovipositor in ♀ nearly always exserted.

Head and body concolorous with wings; the fore (and more weakly the mid) tarsus with dark belts. Abdomen with more or less strong pairs of dorsal spots, the first pair the largest.

Fore-wing rather narrow, termen very gently curved, not crenulate, strongly oblique; SC^1 and SC^2 both from cell; fovea large; light brown,* with sparse dark irroration, costally somewhat more strigulate; markings normal for the *Chogada* group, though generally rather weak, except that the three lines form dark spots at the costa and that the proximal spots of the subterminal are generally strengthened at the costa, before SC^5 and especially between the radials; the whitish cell-mark narrow, its proximal and distal bordering generally narrow, occasionally broader and blacker; median line fine, weak, brownish; the other lines marked with blackish dots or teeth on the veins, occasionally blackish throughout, the postmedian then appearing crenulate; the browner accompanying

* Slightly variable, occasionally inclining towards the "olive-buff" side, oftener towards the "wood-brown." Notwithstanding the footnote on p. 18 of Ridgway's *Color Standards and Color Nomenclature*, the student of Geometrids, who is not a colour specialist, working on some of his most frequently recurring colours, finds great difficulty in using the later plates, on account of the enormous changes that result from a heavy admixture of grey, producing such gaps as, for instance, between the 17‴ and 21‴ series.

shades generally faint; antemedian line rather strongly outbent in the cell; postmedian usually little (as a rule scarcely at all) outbent at the radials, thence with a long but very gentle inward curve before the outward tooth at SM^2; termen with blackish interneural dots; fringe slightly paler, very weakly marked.—*Hind-wing* with termen moderately or rather weakly crenulate; coloured and marked nearly as fore-wing; antemedian wanting, cell-mark somewhat reduced, subterminal spots generally more equalised, or strengthened towards tornus.

Underside slightly paler, the principal markings weakly or moderately reproduced; a narrow shadowy subterminal band present in well-marked specimens, often almost entirely wanting; terminal area pale to whitish.

Marquesas: Hiva Oa (at light unless otherwise noted), 2 ♂♂, 8♀♀, 26.xii.24, one of the ♀♀ with the larger size and more excurved postmedian line of the following species, of which it appears likely to be a worn straggler; 4 ♂♂, 10 ♀♀, 28.xii.24, one ♀ small but sharply marked; 3 ♂♂, 3 ♀♀, 29.xii.24, one ♂ well banded; 12 ♂♂, 8 ♀♀, 30.xii.24, one ♂ a fine aberration, with pale ground-colour, enlarged and darkened cell-spots and heavy bands; 1 ♀ among herbage, 31.xii.24, rather large and well banded; 3 ♂♂, 1 ♀ at 300 feet, 2.i.25; 1 ♂ beaten from herbage at 700 feet, 2.i.25; 10 ♂♂, 4 ♀♀ at 1200 feet, 3.i.25. variable, the cell-spots sometimes strong, one ♂ similar to the aberration of 30.xii.24, but smaller, one with the fore-wing dark-clouded behind the cell and R^2, the hind-wing anteriorly and apically; 2 ♂♂, 1 ♀ at 3500 feet, 28.i.25. Fatu Hiva (at light), 1 ♂ near sea-level, 5.i.25; 2 ♂♂ at 2000 feet, 31.i.25, rather larger; in all three, the proximal subterminal shades are rather well developed. Tahuata (at light), 1 ♂ at 500 feet, 10.i.25; 1 ♂ at 850 feet, 12.i.25. Nuka Hiva (at light), 2 ♀♀ at 100 feet, 15.i.25; 1 ♂, 3 ♀♀ at 200 feet, 16.i.25; 1 ♂ near sea-level, 21.i.25; 3 ♀♀ at 300 feet, 22.i.25; 9 ♀♀ near sea-level, 23.i.25; 2 ♀♀ at 300 feet, 24.i.25.

The Nuka Hiva series contains some rather large and well-marked specimens, in particular with the principal lines rather sharp, but the species is on the whole less variable than many of its congeners. The principal aberrations have been noted above.

The genitalia suggest some affinity with *C. myrmidonaria*, and the ♀♀ of the two species are not dissimilar; the ♂♂ of *myrmidonaria* are in general darker and more heavily marked, besides being appreciably less long-winged; both sexes of that species tend to develop a broader, more irregular white subterminal than that of *collenettei*.

17. **Cleora esoterica**, Prout.

Cleora esoterica, Prout, Entomologist, **62**: 255. (1929) (Marquesas).

♂. 36–39 mm. Very near *C. collenettei* (*supra*). Palpus with the 3rd joint perhaps a little shorter and blunter. Antenna with a rather longer distal portion non-pectinate (about 25 joints, against 20 in *collenettei*). Hind tibia less strongly dilated, with the tarsus relatively longer (¾ or almost). Coloration considerably darker, the body and wings being heavily suffused almost throughout with grey or fuscous; cell-spots enlarged and blackened, as only in rare aberrations of *collenettei*; postmedian line on an average more sinuous; terminal area beneath not so definitely pale; hind-wing with the termen more strongly crenulate.

♀. 36–41 mm. Variable, but distinguishable from *collenettei* by the generally larger size, more variegated colouring (white or whitish ground-colour, with broad brown bands or with dark irroration and narrower band-like shades), median line of fore-wing more strongly developed and deeply inangled between costa and cell-spot, postmedian more

excurved at the radials, altogether more recalling the nature and range of variation of the Melanesian *Cleora* species of the group than does that of *collenettei*; underside with distal area more mottled, sometimes developing anteriorly a broader and stronger subterminal band.

Marquesas: Hiva Oa, 7 ♂♂, 7 ♀♀ at light, 3500 feet, 28.i.25.

The genitalia of several examples of *collenettei*, from different altitudes, and of the present species have been examined by Mr. Tams without yielding any tangible results; there are very small variations in detail, but they do not seem to coincide with the division made on other grounds. At one time I inclined to treat *esoterica* as a mountain race of *collenettei*, but the divergence seems to be too considerable and moreover 2 ♂♂ and 1 ♀ of *collenettei*, quite agreeing with examples from 1200 feet, were taken with *esoterica* at the high altitude. It even appears, as noted above, that one straggler of the last-named was taken at near sea-level.

A ♀ from Nuka Hiva, 300 feet, 22 January, 1925, taken with 3 ♀♀ of *collenettei*, is evidently also a form of the present species, rather darker brown and more uniform than any of the topotypical ♀♀ and with the postmedian of the hind-wing more deeply incurved in its proximal half, though the Hiva Oa ♂♂ approach it in this respect.

18. **Cleora leucostigma,** sp. n.

♀. 31 mm. Face and palpus fuscous, the face with rather strong cone below, the palpus 2, with second joint heavily scaled above and beneath, 3rd joint shortish-moderate, somewhat deflexed. Antenna fuscous-black, moderate, very shortly ciliate and with single bristles, the long scales at the ends of the joints rather strongly projecting. Fillet fuscous; occiput and collar ochreous. Thorax and abdomen above fuscous mixed with black, beneath more drab; thorax with small double posterior crest. Ovipositor exserted, moderate, the arms divaricating distally. Legs fuscous, the fore leg more blackish, with sharply pale spots on tibia and at ends of tarsal joints, the others more mottled.

Wings shaped about as in *fenestrata*, Prout (1916), or with the hind-wing slightly longer costally.—*Fore-wing* with SC^1 free, SC^2 from cell, closely approaching the stalk of SC^{3-4}; glossy fuscous (paler, mixed with blackish fuscous); in places a slight sprinkling of bright ochreous scales, especially in costal region, where there are more definite dots and strigulae, and on the principal veins, producing dots or minute dashes; cell-spot rather large, reniform, black, succeeded distally by a more quadrate, cream-white spot which reaches the postmedian; lines blackish, lunulate-dentate, defined chiefly by pale lines on their reverse sides, at costa 6 mm. apart, at hind margin scarcely over 3 mm., the postmedian bending inward from R^3 to fold; two ill-defined pale lines in proximal area; median shade very indistinct, blackish, just proximal to the cell-spot, at hind margin close to the postmedian; subterminal whitest anteriorly, throughout fine, somewhat interrupted, especially about the radials, where there is discernible an oval blackish spot proximally; a faint and diffuse pale line between postmedian and subterminal; terminal line broad but very inconspicuous; fringe dusky, its basal pale line not striking.—*Hind-wing* glossy drab, shaded with hair-brown or greyish; a moderate-sized, rather weak cell-spot and a rather weak postmedian line; other markings quite faint.

Both wings beneath coloured and marked more nearly as hind-wing above, the fore-wing, however, with pale-speckled costal region and indications of the pale spot outside the cell-spot, the hind-wing with cell-spot stronger than above.

Marquesas: Hiva Oa, 1 ♀ (holotype) at light, 3500 feet, 28.i.25.

Affinities doubtful. The shape, the dense and glossy scaling and the pattern indicate that it is not a *Cleora* in the strictest sense, even if the ♂♂ do not

furnish further distinctions. Possibly nearer to *C. fenestrata*, Prout, from New Guinea, than to anything else yet known to me.

19. Cleora (Cerotricha) licornaria, Guén.

Cerotricha licornaria, Guen., Spec. Gén. Lép., ix: 285, pl. 20, f. 3 (1858); Prout, Ins. Samoa, iii (3), p. 154 (1928) (Tahiti).

This interesting species unfortunately was obtained neither by the "St. George" expedition nor by Miss Cheesman, but is added here for the same reason as *Anisodes samoana* (*supra*), namely that a complete survey of the hitherto-known Geometrid fauna of Palaeonesia should be brought within the compass of a single memoir. The ♂ genitalia have been examined by Mr. Tams and strengthen the impression that we have here an outlier of *Cleora* which could, if it were proved to be a representative of a distinct group of species, be regarded as a genotype, but which, in the absence of such a group, seems to be best treated as an aberrant member of *Cleora*. As noticed above, it is in some measure connected with the more typical species by *C. stenoglypta* and there are also other possible inter-relations which will deserve closer study. To the published record in Guénée are to be added the following:—

Society Islands: Tahiti, 1 ♀ (*J. J. Walker*). Eimeo I. (Moorea), 1 ♂, 6–9. iv.83 (*J. J. Walker*). Both examples are in the British Museum collection.

BRITISH NON-BITING MIDGES (DIPTERA, CHIRONOMIDAE)

By F. W. Edwards.

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[Read October 2nd, 1929.]

Plates XVII–XIX and Fifteen Text-figures.

This paper (a sequel to one on the biting midges, published in these *Transactions*, Dec. 1926) embodies the results of a number of years' work on the Chironomidae, and includes keys to, and brief descriptions of, all the species hitherto found in this country. It is nevertheless far from being a complete account of our fauna. In the first place, it is certain that a great many species remain undiscovered, because a single day's collecting in any favourable locality still rarely fails to produce one or more additions to the total. Secondly, our knowledge of the distribution of the known species is still very meagre, and many which appear rare are probably widely spread and common in some districts. Thirdly, almost nothing has been done here by way of rearing these insects, and until this omission has been remedied no true idea of their relationships nor of specific limits can be obtained, nor can the nomenclature be correlated fully with that employed by continental workers. In the meantime, however, it appears desirable to publish a preliminary revision confined to a consideration of the adults, which will serve as a basis for further work and for the identification of at least the majority of the commoner species.

As originally planned, the paper was to have been a joint one by myself and the late Mr. G. Grace of Ilkley, from whom I received much valuable assistance during the years 1922–6. Mr. Grace had intended to contribute a rather full introductory account of the midges, elaborating a paper which he published in the *Naturalist* for 1925. Unfortunately Mr. Grace's lamented death in November 1926 has necessitated a change of plan. The notes which he had made for this introduction were not sufficiently advanced to make it possible to include it here as his work, and I therefore omit it, referring readers to the *Naturalist* paper for an introduction to this study. I am indebted to Mr. Grace for several suggestions on classification, as mentioned in the text, as well as for much material from Yorkshire, collected either by himself or by others whom he had succeeded in interesting in the subject. I am further indebted to a number of other correspondents who have sent me material from time to time, particularly to Mr. H. Britten, who has submitted extensive collections from the north of England.

The recent literature on European Chironomidae is voluminous but largely unsatisfactory, because it is often difficult or impossible to determine the species from the imperfect descriptions of the late Abbé J. J. Kieffer. Students will, however, find the papers of Goetghebuer, which are usually well provided with excellent figures, indispensable. On British species very little has been published since Walker's *Insecta Britannica* (1856). Practically none of the names introduced by Walker are accompanied by recognisable descriptions, but an examination of the types has enabled me to determine most of them; all but 5 of the 99 types were traced and most of these were recognisable. Not infrequently the specimens labelled by Walker disagreed with statements

in the description, but this was usually clearly due to faulty observation, as when Walker mistook a middle for a front leg through its being turned forwards, or a denuded wing for a bare one, or overlooked the cross-vein in a *Tanypus* or a *Diamesa*. In some cases more than one species was represented in the short series standing above Walker's label; where this was so, I have selected as type the specimen most nearly corresponding with the description. Walker's names are noted in the text, the majority of them falling in the synonymy. The missing types are those of *C. compertus*, *C. disclusus*, *C. minusculus*, *C. morulus* and *C. moturus*.

In addition to studying Walker's types, I have also examined the collections of Meigen at Paris; of Staeger at Copenhagen; of Zetterstedt at Lund; of van der Wulp at Amsterdam and Leyden (very little is left of this); of Holmgren at Stockholm; and of Winnertz at Bonn. I have thereby been enabled to identify a considerable number of species described by these authors which had not previously been recognised with certainty. Some of the types will, however, require a second and more minute examination before they can be accurately placed. According to information supplied by Mr. A. W. Stelfox, few or no types remain in Haliday's collection at Belfast.

A large proportion of our species has been identified as having been described by the older authors or more recently by Goetghebuer or Kieffer, but there remain many of which I have not at present been able to trace published descriptions. Among these I have described as new those which seem to me distinct enough to be recognised with certainty from the descriptions given; a few obscure species remain, which I have refrained from naming. It is probable that many of the species treated here as new were described by Kieffer, and if his types can be examined some changes in nomenclature may be expected. I have not thought it worth while to revise the old records of Curtis, Stephens and Walker, except for attempting to fix the new names they proposed. The total number of British species recognised in this paper is 373 (nearly three times the number mentioned in Verrall's list of 1901); of these 83 are described as new.

Although it is not yet possible to compare in detail the Chironomid fauna of Britain with that of other countries, it is already becoming evident that many of our species have an extremely wide distribution. As might have been anticipated, nearly all the species described by Goetghebuer from Belgium have been found to occur here, but it is of rather more interest to note that even minute species such as *Spaniotoma coerulescens*, Kieff., and *Corynoneura scutellata*, Winn., range without appreciable variation from Britain to the Alps. Much more remarkable is the discovery that *Podonomus peregrinus*, Edw., which I first found in Scotland, is common in the Southern Andes. It is also worth calling attention here to the probability (mentioned later) that *Cardiocladius fuscus*, Kieff., from Middlesex is identical with *C. ceylonicus*, Kieff., from Ceylon and Java, and that *Limnophyes pusillus*, Eaton, first described from Kerguelen I., is the same as the common European *Camptocladius exiguus*, Goet. In view of such facts it seems probable that many of the smaller species of this family will be found to be spread throughout the world, perhaps by the agency of wind.

Collection and Preparation.

Owing to their swarming habits, the males of most species of Chironomidae are very easily collected with the net; females are less easily obtained, but may usually be found by beating or sweeping vegetation in the neighbourhood of the

swarming males. As the sexes are frequently very different in appearance, it is desirable whenever possible to obtain mating pairs. This may often be done by watching a swarm until a female makes her appearance and pairs with a member of the swarm; the pair immediately drop out and can be secured as they come to rest. Swarming is usually most active about an hour before sunset in summer, or about midday in winter, but the time of swarming varies much with the species; some, such as *Chironomus pedellus*, are most active at late dusk. The swarms are usually seen in sheltered places over some raised object. When in camp I have found a "cottage" tent much favoured by swarms of midges, and as the mated pairs settle on the roof they are easily boxed.

The height at which swarming takes place varies to some extent with the nature of the surroundings and with atmospheric conditions, and also with the species; some TANYPODINAE, for example, swarm rather high up, and *Graceus ambiguus* remains close to the surface of water. The number of individuals in the swarm varies greatly, usually in accordance with the abundance of the species in the locality, although some species (e.g. *Ch. plumosus*, L.) never seem to form large swarms.

Some species mate on the ground or on the surface of water, and these are less readily collected; such habits perhaps explain why the genera *Corynocera*, *Hydrobaenus* and others have not yet been found in this country.

CHIRONOMIDAE may often be taken in large numbers on fences, especially near water; this method of collecting is sometimes more satisfactory than the use of the net, as the specimens can be more readily obtained in perfect condition. In any case, in order to obtain good material for study it is essential that midges should either be pinned in the field or else brought home alive in pill-boxes or tubes, only a few specimens (and no insects of other groups) being placed in each box.

A wide field is open to future students who will undertake the task of rearing the species from larvae. When this is done it is frequently found that insects which are scarcely distinguishable as adults have totally different breeding habits, and are evidently distinct species. The variety of larval habit and habitat is much greater than was at one time supposed, and although this paper is not concerned with the early stages it may not be out of place to summarise the conditions under which the larvae live. It was formerly believed that all or almost all larvae of this family were aquatic, but it is now known that there are numerous terrestrial forms, occurring in moss, rotten wood, horse and cow dung, at roots of grass and in humus generally. One or two of these (e.g. *Spaniotoma furcata*, Kieff., mentioned below) have been found to be greenhouse pests, attacking the roots of seedlings. The terrestrial forms of larvae do not form a natural group; they occur in various genera of the ORTHOCLADIINAE, and even of two closely related species (e.g. *Metriocnemus fuscipes*, Mg., and *M. martinii*, Thienem.) one may be wholly terrestrial and the other wholly aquatic. Many of the terrestrial species appear to be mainly winter insects.

Among the aquatic species there is a great variety of habit. Some are true parasites (e.g. *Symbiocladius* on may-fly nymphs and perhaps some species of *Chironomus* on water-snails); others are commensal with insect larvae of other orders; others are leaf-miners, some of these being confined to a particular species of plant; a few live in freely movable cases of definite form (*Zavrelia*, *Lauterborniella*); many form fixed cases, and others live free in mud; many (including most of the TANYPODINAE) are predaceous. All types of water are inhabited

by midge larvae; naturally the species living in swift rivers and streams ("rheophilous") are usually different from those in stagnant water ("limnophilous"), but pairs of closely related species are frequently found in the two types of habitat. A few (e.g. *Cardiocladius capucinus*) are found on rocks in waterfalls, and several live in the sea.

This diversity of breeding habits is no doubt the explanation of the surprising diversity of Chironomid fauna, even between near-by localities. The faunal lists of an area of marsh or bog, a large weedy pond in a wood, and a mountain lake would show very few species in common. Yet the lists for similar localities in different parts of the country (such as the lakes of Windermere and Killarney or the similar woodland ponds of Witherslack, Gormire and Epping) would be almost identical.

The terrestrial larvae, as well as those living in stagnant or slowly-moving water, are very easily reared. A convenient receptacle is a tin with a hole in the lid over which a glass tube or a glass-bottomed box may be fitted; the adults on emergence fly up into the tube and are easily removed.

Part of the difficulty of deciphering Kieffer's descriptions is due to the fact that he apparently always described from spirit or slide material. Although it is of course necessary to prepare mounts of specimens, or at least of the hypopygium, before a species can be fully described, I very much prefer to have all material pinned in the first instance; * even the very smallest specimens can with practice be pinned under a lens on the point of a fine steel pin, in such a way that nearly all their characters (except details of hypopygium) can be seen under the highest available power of a binocular microscope. If on the other hand specimens are preserved in spirit, not only do the colours eventually fade, but it becomes much more difficult and sometimes impossible to observe other more important features, such as the course of the faint veins of the wing (R_{2+3} and *An*); colour of wing-membrane; nature of squamal fringe; presence of humeral pits; pruinescence of thorax, etc. Moreover, specimens are fully as liable to damage by shaking about in spirit as by other accidents when pinned. If the specimen has been pinned first, all the above-mentioned features may be noted before a mount is made, and in most cases it will only be necessary to break off and mount the tip of the abdomen (or the whole abdomen in the case of a small specimen). For the preparation of hypopygia, etc., I use the following method: (1) Place the specimen in strong potash in a tube, the tube being placed in an outer vessel containing water, which is just brought to the boil. (2) Remove from potash to glacial acetic acid, to which a few drops of Ziehl's carbolic fuchsin have been added (this operation may be omitted if specimen does not need staining); (3) after five minutes or so remove to pure glacial acetic acid; (4) after a minute or two (a few seconds if stain has been used) remove to clove oil; (5) mount in a very small drop of balsam on a small celluloid strip, arranging specimen in desired position with needles under binocular; (6) when dry and set, add a little more balsam until specimen is completely covered. The celluloid strip can be placed on the pin with the remainder of the specimen. No matter for how long an insect has been dried, good preparations can always be made in this way; on the other hand, if it has been long in spirit the result is seldom so good. If the whole insect is to be mounted, the wings should be removed first and mounted dry or placed directly in balsam; they should not be boiled.

* Instead of being pinned specimens may be stuck on card or celluloid points; in the latter case the best adhesive to use is a solution of celluloid in amyl acetate.

Examination.

It may be as well to mention here the main characters used for specific diagnosis, and the significance of certain terms and abbreviations used in the text. These are as follows :—

Head.

Shape of eyes.

Presence or absence of pubescence of eyes. The pubescence is always short, and may (as in *Smittia*) require a magnification of 150 before it can be seen.

Number of segments in antennae.

Length of last segment of ♂ antenna in relation to the remaining segments of the flagellum. This is expressed as a decimal and designated by the letters A.R. (antennal ratio). As a rule I have not made very exact measurements of this ratio, but have estimated it in the dry unmounted specimen; the degree of variation is usually more than the probable error of observation.

Form of sensory organs of ♀ antennae. These usually occur in pairs on the apical part of the third and following segments; the last segment may have none or may have several pairs. The structures are hyaline, and the head may require mounting and staining before they can be seen. Chiefly used in Orthocladiinae. The sensory organs are hollow membranous extensions of the cuticle, thus differing from the ordinary hairs and bristles which are solid chitin and articulated at the base.

Relative lengths of palpal segments (I have not made use of these characters; specific differences certainly exist, but are usually not readily seen in pinned specimens).

Thorax.

Form of pronotum (especially in Chironominae and Tanypodinae).

Size of shining area at base of scutellum (useful in *Orthocladius*).

Number of dorsocentral hairs (occupying spaces between scutal stripes), their length and colour.

Degree of pruinosity.

Size of humeral pits (occasionally useful, as in *Trichocladius*).

The colour of the thorax, and the condition of the scutal stripes (whether separate or fused) not only differs with the sex and age of the individual but is very variable seasonally and individually in a great many species, and can seldom be used for specific definition. Further, in species with very thin integument the thoracic muscles may give the scutum a striped appearance, especially after drying, even if the colour of the integument is quite uniform.

Abdomen.

The most important specific differences are of be found in the hypopygium of the male, especially (*a*) presence or absence, and form when present, of *anal point* (a sharp projection from middle of ninth tergite); (*b*) form of *style* * or clasper, which may appear very different according to whether the style is extended or reflexed; (*c*) form of lobes or appendages (if any) of *coxite* * (or basal segment).

* In this paper I have used the terms *style* and *coxite*, which I believe to be morphologically correct, in place of clasper (or dististyle) and side-piece (basistyle or basal segment of forceps).

LEGS.

Form and number of tibial spurs and combs. These can be studied in dry material under a binocular microscope if the tarsus is broken off carefully by bending upwards.

Length of first segment of tarsus relatively to the tibia; this is expressed as a decimal and designated L.R. (leg ratio). Unless otherwise stated L.R. always refers to the front legs. As with the A.R., the figure given is usually an approximate estimate rather than an exact measurement, since experience has shown that there is considerable variation.

Presence or absence of minute spurs at tips of first one or two segments of middle and hind tarsi.

Relative lengths of last two tarsal segments.

Presence or absence (and size when present) of pulvilli.

Length of empodium relative to claws.

Presence or absence of " beard " of long hairs on front tarsi of ♂. (This is seldom a good specific character, as the length of the beard is often variable, and the hairs are easily broken off.)

WINGS (general features).

Colour of wing by reflected or transmitted light (see note under subgenus *Orthocladius*, p. 336).

Nature of markings (if any).*

Shape of *anal lobe* of wing; whether produced, right-angled, rounded, obtuse obsolete or absent. The sexes differ somewhat in this respect, and though the ♂ has narrower wings than the ♀, the anal lobe is usually better developed in the former sex.

Distribution of hairs (macrotrichia) on wing-membrane, and presence or absence of microscopic hairs (microtrichia) covering membrane.

Presence or absence (and extent when present) of a fringe of hairs on the squama. This fringe, being on a protected position, is not at all readily denuded.

VENATION.

In this paper the Comstock-Needham terminology has been adopted; Kieffer and Goetghebuer use the earlier terminology of Schiner. The chief points to note are :—

Whether or not the costa is *produced* beyond the end of R_{4+5}, and to what extent.

Relative lengths of R_1 and R_{4+5}.

* The wing-markings of CHIRONOMIDAE (and CERATOPOGONIDAE) may be due to one of four causes, or a combination of some of them: (1) Dark stains on the membrane; (2) patches of darker microtrichia; (3) patches of darker or lighter macrotrichia; (4) absence, or differences in density, of microtrichia or macrotrichia in certain areas. Markings due to (1) cannot be denuded and are equally clearly visible by reflected or transmitted light, as in *Tanypus punctipennis*. Those due to (2) also cannot be denuded, but are visible best by reflected light under a lens; the wing should be held with the apex much nearer the lens than the base, so that the observer looks almost along the length of it; a dark background is sometimes an improvement. When such a wing is examined dry by transmitted light, the markings become almost invisible, but if it is mounted in a liquid medium the markings are equally distinct by reflected or transmitted light. Examples of such wings are *Culicoides* and some species of *Chironomus* (*Polypedilum*). Markings of type (3) are of course lost when the wing is denuded, and can only be seen to advantage by reflected light in the manner just described, perfect specimens being essential; many species of *Pentaneura* are of this type. Markings of type (4) are less frequent; examples are *Eurycnemus* and some species of *Anatopynia*.

Position of tip of R_{2+3} (the faint vein between R_1 and R_{4+5}), in relation to tips of R_1 and R_{4+5}. This sometimes varies slightly with sex, but is nearly always constant for species or groups of species.

Length of cross-vein *r-m*, and size of angle it makes with *M* or R_{4+5} (whether approximating to the transverse or to the horizontal).

Position of tip of R_{4+5} in relation to that of Cu_1. An imaginary line is drawn at right angles to the main axis of the wing from the tip of Cu_1, and the position of the tip of R_{4+5} proximal or distal to this line affords a useful group character.

Presence or absence of cross-vein *m-cu*.

Position of base of cubital fork (*fCu*) in relation to the point where *r-m* meets *M*.

Curvature of Cu_2

Length of anal vein (*An*), and whether or not it is curved down at the tip. The true anal vein must not be confused with the fold which lies below it (often

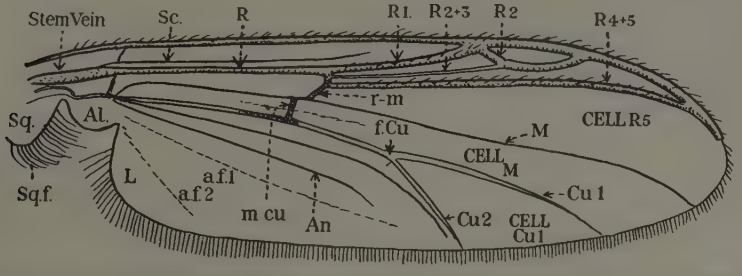

FIG. 1.—Wing of *Procladius flavifrons*, sp. n., to illustrate Chironomid venation. Notation of veins after Comstock and Needham. *Sq*, squama. *Sq.f.*, squamal fringe. *Al*, alula. *L*, anal lobe of wing. *a.f.*1 and *a.f.*2, the two anal folds (vein *Ax*, when present, lies between these two folds; *a.f.*2 is frequently absent). *fCu*, base of cubital fork. *r-m*, cross-vein.

conspicuous and simulating a vein) nor with the vein which lies between it and the cubitus (usually unnamed, but regarded by Tillyard as a branch of the cubitus).

For a preliminary examination a hand lens magnifying 15 diameters is extremely useful, but for accurate determination a microscope is essential. I habitually use a Zeiss binocular with eye-pieces Nos. 4 and 5 and objective a_3, combinations which give magnifications of 80–120. I find that with a binocular of this magnification it is possible to see almost as much as with a magnification of 300 under a monocular (for example one can count the segments in the antenna of a *Corynoneura*); nearly all the characters mentioned above are readily observed at a magnification of 80, but for finer details a monocular with $\frac{1}{6}''$ objective is needed.

Classification.

In recent years three subfamilies of Chironomidae have usually been recognised: Ceratopogoninae, Tanypodinae and Chironominae. The first of these is so distinct in many ways from the others that it is probably better separated as a distinct family, a course which was first taken by Malloch. In my revision of the British Ceratopogonidae (*Trans. Ent. Soc.*, 1926) I enumerated the main distinctions between the adults of the two families, but over-

looked one rather obvious difference: the postnotum of the CHIRONOMIDAE almost invariably has a distinct median longitudinal furrow or keel, which is quite lacking in the CERATOPOGONIDAE.

The remaining groups are quite closely allied, but the former consists of two and the latter of three rather well-marked groups, which seem to be of about equal value morphologically. I therefore propose to recognise five subfamilies which may be separated as follows:—

1. Cross-vein *m-cu* present . . . . . 2.
   Cross-vein *m-cu* absent . . . . . 3.
2. R_{2+3} either present and forked (*i.e.* connected with R_1 by a cross-vein), or else absent altogether (Plate XVII, figs. 1–3; text-fig. 1) . 1. TANYPODINAE.
   R_{2+3} present and simple; not connected with R_1 and always distinct (Plate XVII, figs. 4–6) . . . . . 2. DIAMESINAE.
3. L.R. less than 1; front tibia with spur; male styles folded inwards . . 4.
   L.R. nearly always more than 1; front tibiae rarely with distinct spur; male styles directed rigidly backwards . . . . . 5. CHIRONOMINAE.
4. Pronotum scarcely divided; anepisternal suture well developed (fig. 9*a*); male antenna normally plumose . . . . . 3. ORTHOCLADIINAE.
   Pronotal lobes widely separated; anepisternal suture obsolete (fig. 9*b*); male antenna not plumose . . . . . 4. CLUNIONINAE.

This arrangement is the same as that adopted by Thienemann, except that the DIAMESINAE are separated as a distinct subfamily, instead of being included in the TANYPODINAE (as formerly) or the ORTHOCLADIINAE (as more recently). The TANYPODINAE have retained the greatest number of primitive characters (presence of R_2 and *m-cu*, and of macrotrichia on wing-membrane; numerous segments in ♀ antennae, etc.), and are therefore placed first, although most or all of them have specialised in other directions (predacity of larvae; reduction of basal parts of hypopygium) and are not in the direct line of ancestry of the other groups; they would seem rather to have been developed from some primitive member of the DIAMESINAE. The other four groups appear to have had a common origin; the most specialised, evidently, are the CHIRONOMINAE with their lengthened front tarsi and highly modified tibial combs and male styles.

All known genera of CHIRONOMIDAE can be referred to one of these five subfamilies, with the possible exception of *Nepalia*, Kieff., described from a single specimen from the Himalayas, which is now unfortunately lost. Several distinct European genera have not yet been found in Britain; I have mentioned these in the introductory paragraphs to each subfamily.

Subfamily TANYPODINAE.

I follow Goetghebuer and Thienemann in restricting the extent of this subfamily to the genus *Tanypus* in the sense of Meigen. *Diamesa* and its allies were formerly included here by Kieffer, but it had long been recognised (notably by Haliday) that they were more nearly related to *Chironomus* (in the wide sense) than to *Tanypus* and in this paper they are treated as forming a separate group. Kieffer in his later papers accepted this restriction of the TANYPODINAE. It must be admitted, however, that this course renders the definition of the subfamilies somewhat unsatisfactory, at least as regards the adults. There appears, indeed, to be an almost complete gradation among our British forms between typical TANYPODINAE and typical ORTHOCLADIINAE. The characters of the present subfamily, as now limited, are the following:—

Cross-vein *m-cu* always present. R_{2+3} normally present and forked, a short cross-vein (R_2) connecting R_{2+3} with R_1; in a few cases R_{2+3} (together with R_2) is either absent or difficult to see, but in these, as well as in most of the other species, the wings are densely hairy. Male antennae 15-segmented, though the joint between the last two segments is sometimes not very clearly marked; the 14th segment is always much longer than the 15th. Female antennae with 12–15 segments. Hypopygium rarely with distinct basal appendages or lobes to the coxites; styles folded inwards and with distinct terminal spine.

Most recent writers have subdivided the old genus *Tanypus*. It may perhaps be questioned whether this was desirable, since the group is a very natural one and rather easily circumscribed in the wide sense, while the smaller groups into which it has been divided are not quite so readily defined. However, these divisions have been so widely adopted that it may be as well to accept at least some of them. Unfortunately this cannot be done without some modification of the nomenclature, necessitated through Kieffer's mistaken use of certain names; the reasons for the changes I have made are fully stated below.

It has been customary to base the primary division of the subfamily upon the position of *m-cu* before or after the base of the cubital fork. In view, however, of the researches of Thienemann and Zavrel on the larval and pupal stages, it would seem that a more natural cleavage is between those genera in which the costa is strongly produced and the genus *Pentaneura* with unproduced costa. This line of division brings out the fact that *Macropelopia* and *Psectrotanypus* are more nearly related to *Tanypus* than to *Pentaneura*.

I propose to recognise only six British genera, and to distinguish them as follows :—

1. *Cu* forking just before the cross-vein (Plate XVII, figs. 1–3) . . . . . 2.
   Cu forking beyond the cross-vein; costa produced (text-fig. 1) . . . . . 4.
2. Costa distinctly produced; ♀ antennae with 15 segments . . . . . 3.
   Costa not or scarcely produced; ♀ antennae with 12–13 segments *Pentaneura*.
3. R_{2+3} present and forked . . . . . *Anatopynia*.
   R_{2+3} absent, R_1 and R_{4+5} also being well separated . . . . *Podonomus*.
4. Stem of cubital fork more than half as long as Cu_2 . . . . . 5.
   Stem of cubital fork less than one-third as long as Cu_2 . . . . *Tanypus*.
5. Fourth tarsal segment cordiform, much shorter than fifth . . *Clinotanypus*.
   Fourth tarsal segment cylindrical . . . . . *Procladius*.

Two Palaearctic genera of doubtful validity have not yet been found in Britain.

Trissopelopia, Kieff. (1923*c*). According to the description this would appear to have the venation of *Anatopynia*, but antennae of ♀ only 12-segmented; small, narrow pulvilli present.

Stenotanypus, Kieff. (1926*b*). From the description this would appear to be related to *Podonomus* (R_{2+3} said to be absent, styles double, etc.) but has bare wings.

Pentaneura, Phil.

(*Ablabesmyia*, Joh.; *Isoplastus*, Skuse; *Peritaphreusa*, Beck.; *Tanypus* auct.)

Wings densely hairy. Costa not or only very indistinctly produced; R_2 normally present; *m-cu* placed immediately beyond *fCu*. Antennae of ♀ with 12–13 segments. Pronotum more reduced than in other genera of the subfamily. No tarsal spurs. Pulvilli usually absent.

The name *Pentaneura* was introduced by Philippi in 1865 for a Chilean species; the genus has not been recognised by other workers, probably because Philippi described and figured a quite impossible wing-venation. It seems to me quite obvious that he described a species related to *Tanypus falciger*, Kieff., and misinterpreted the venation on account of the dense pubescence of the wings, regarding *r-m* as the base of R_{4+5} and treating *M* as a branch of the radius, at the same time overlooking the apical part of R_{4+5} (where it lies very close to the costa) and the end of Cu_2 (which may appear very faint from some points of view). In support of this contention I may say that I have taken in Patagonia and Chile a species which I believe may be Philippi's *P. grisea* and is very similar to *P. falciger*. I therefore propose to adopt Philippi's name in place of the cacophonous *Ablabesmyia*, which applies to the same group of species. I have explained below (under genus *Tanypus*) my reasons for reverting to the arrangement of Johannsen (1905).

Peritaphreuusa has been recognised by Kieffer and Goetghebuer as a subgenus, on the ground that the female antennae have 13 instead of 12 segments. I cannot agree with this, however, as the three British species which have 13-segmented antenna (*phatta*, *guttipennis*, and *binotatus*) are obviously not nearly related, while two of them have close relatives among the species with 12 segments. Similarly I regard the occurrence of pulvilli as sporadic only.

In a few species R_{2+3} has lost the fork, and in one or two it is entirely absent. This is a parallel development to that of *Podonomus*, but in the present case there is no sharp dividing line by which these species may be separated from the rest of the genus; in all of them R_1 and R_{4+5} are closely approximated and R_{2+3} has simply been crowded out.

The genus *Pentaneura* as here employed includes the majority of the species hitherto placed in *Tanypus*; we have thirty in Britain, which may be arranged in six groups. Nearly all may be recognised in life from other genera of the subfamily by their habit of holding their wings divaricate in repose.

Key to Groups.

1. Wings with markings, even if faint; legs sometimes ringed . . . . . 2.
   Wings quite unmarked; legs light or dark, but without darker rings, even at tips of femora . . . . . 4.
2. A dark ring near middle of each tibia . . . . . *Group A.*
   No such rings present . . . . . 3.
3. Wings dark with light spots . . . . . *Group B.*
   Wings light with dark bands, spots or clouds . . . . . *Group C.*
4. Wing-length 3·5 mm. or more; R_{2+3} distinctly present and forked . *Group D.*
   Wing-length 3 mm. or less; R_{2+3} faint, fork indistinct or absent . . . 5.
5. R_{4+5} ending beyond or above level of tip of Cu_1 . . . . . *Group E.*
   R_{4+5} ending before level of tip of Cu_1 . . . . . *Group F.*

Group A.

(*Isoplastus*, Skuse; *Ablabesmyia*, Joh.; *Pelopia* auct.)

Wings with numerous dark bands on a light ground. R_{2+3} distinctly present and forked. Legs whitish, with numerous dark rings, one near middle of each tibia, others at tips of femora, tibiae and most of the tarsal segments, and at bases of tibiae. Male styles rather peculiar, with the tip narrowed and blackened, spine bristle-like and inserted well before the tip, with which it lies parallel.

This includes two British species, which are not very well distinguished. *P. monilis* appears to have a nearly cosmopolitan distribution. The wings in both species are held in a more or less roof-like position, not divaricate as in other species of the genus.

P. monilis (L.). Front tarsus of ♂ with beard short or absent. Antennae of ♀ normally 12-segmented. Wing-length under 3·5 mm. Very common.

The wing-markings are rather variable, as also is the colour of the abdomen; often the first few segments are pale, but they may have dark longitudinal markings, and sometimes the whole abdomen is dark. An unusually dark variety from Poynton, Cheshire (*Britten*) and Oxford (*Hamm*) has the legs very extensively dark, the two outer dark rings of the tibiae indistinctly separated, as are the two rings on the first segment of each tarsus, though the base of this segment remains white.

P. phatta (Egg.). Front tarsus of ♂ with long beard. Antennae of ♀ 13-segmented. Wing-length usually over 4 mm. Hypopygium identical with that of *P. monilis*. Rather common.

Group B.

Wings with numerous whitish spots on a dark ground. R_{2+3} and R_2 fairly distinct. Legs mainly dark, with narrow white rings at bases of tibiae and first tarsal segments.

P. guttipennis (v.d.W.) (? *zavreli*, Kieff.). A small species, wing-length about 3 mm.; easily recognised as it has no close ally in Europe. Antennae of ♀ 13-segmented. Rather common.

Group C.

Wings with more or less obvious dark markings on a light ground. R_{2+3} distinct and forked. Wing-length 3–4 mm. Legs usually pale, without dark rings except (in some species) at or close to tips of femora.

This includes about ten British species most of which are quite distinct and easily recognisable.

1. Femora with a dark ring at or close to the tip . . . . . 2.
   Femora without such ring . . . . . 6.
2. Wing-markings distinct; cross-veins blackened . . . . . 3.
   Wing-markings faint and ill-defined; cross-veins pale . . . *woodi*, sp. n.
3. Palpi blackish; scutal stripes dark brown, almost uniform; a dark cloud below tip of R_{4+5} . . . . . 4.
   Palpi yellow; scutal stripes reddish, the front ends of the lateral pair and the middle of the middle pair black . . . . . 5.
4. Black dots over R_2 and the tip of R_3; a grey cloud near base of cell R_5 *eximia*, sp. n.
   These markings absent . . . . . *lentiginosa*, Fries.
5. Pulvilli present; no dark mark below tip of R_{4+5} . . . . . *ornata*, Mg.
   Pulvilli absent; a dark mark below tip of R_{4+5} . . . *maculipennis*, Zett.
6. Cross-veins black; wing-tip broadly pale . . . . . 7.
   Cross-veins hardly darkened; outer dark markings of wing almost reaching the tip . . . . . 9.
7. Darker; head black; ♂ styles enlarged at base . . . . *fusciceps*, sp. n.
   Lighter; head yellow; ♂ styles not enlarged at base . . . . . 8.
8. Scutal stripes brown, the anterior ends of the lateral pair darker; outer wing-band broad . . . . . *carnea* var. *festiva*, Mg.
   Scutal stripes uniformly light reddish; outer wing-band narrower *carnea*, F.

9. A dark spot (usually separate) in middle of cell R_5 . . . . . 10.
   Middle part of cell R_5 pale . . . . . 11.
10. Basal cells clear; ♂ front tarsus with longish beard . . *hirtimanus*, Kieff.
    A dark band across outer half of basal cells; ♂ front tarsus without beard *northumbrica*, sp. n.
11. Wings with two dark bands, the first blacker and placed immediately distal to the cross-veins . . . . . *nubila*, Mg. (*dubius*, Staeg.).
    Wings with four faint grey blotches on the outer half, and another in the anal cell; body nearly all yellow . . . . . *pallidula*, Mg.

P. lentiginosa (Fries). Sufficiently distinguished by the characters mentioned in the key; also by having three distinct black spots at the base of each abdominal segment (often fused in ♂). I use the name in the sense in which it was applied by Verrall, as our specimens agree with Fries' description. I have not seen the types; the specimens determined as *lentiginosus* in Zetterstedt's collection are not the present species but *P. carnea*. The wing-markings of this and the next three are very similar. Rather common.

P. eximia, sp. n. (Verrall MS.). ♀. Femora with a dark brownish pre-apical ring as in *P. lentiginosa*, *P. maculipennis* and *P. ornata*; wing-markings (Plate XVII, fig. 2) also similar, but differing from all these three species in having distinct blackish dots over R_2 and the tip of R_3 (as in typical *P. monilis*), and three separate dark spots in cell R_5, the additional one being placed near base of cell. Palpi blackish, as in *P. lentiginosa*; scutal stripes dark grey, almost uniform and almost confluent. Abdomen greyish, tergites with black basal bands. Wing-markings more sharply defined than in *P. lentiginosa*, more resembling those of *P. maculipennis*. No pulvilli. Wing-length 3 mm.

Llangollen, 18.vii.1888, type ♀ (*Verrall*). Reinacharn, 28.viii.1900, 1 ♀ (*Jenkinson*).

P. ornata (Mg.). Meigen's type being lost, I follow Kieffer and Goetghebuer in their use of this name. Although differing from its allies in the possession of pulvilli, this species is so similar in nearly all other respects to the following that it is clearly impossible to place it in a separate genus with comparatively unrelated species such as *P. longimanus*. It appears rare in Britain. Oxford (*Hamm*); Attenborough, Notts. (*Carr*).

P. maculipennis (Zett.) (? *laetus*, Mg., Goet.; *costalis*, Kieff., 1911*a*; *subincurvatus*, Goet., 1923*a*). Highly ornamented species, but closely resembling *P. ornata*; wing-markings practically identical with those of *P. lentiginosa*, but clearer and rather more extensive. Abdominal segments (in ♂) with brown transverse bands at base, not broken up into definite spots. Ilkley (*Grace*); Dovedale (*Verrall*); Melkinthorpe, Westmorland (*Britten*); Staveley and Temple Sowerby, Westmorland (*F.W.E.*); Radcliffe-on-Trent, Notts. (*Robinson*); Nesfield (*Grimshaw*).

P. fusciceps, sp. n. ♂. Head blackish, including whole of face, proboscis, palpi and antennae; back of head rather lighter. Thorax with dull brownish ground-colour; scutal stripes almost black, rather strongly pruinose with whitish; scutellum yellowish; postnotum and sternum black. Abdomen light brownish; tergites 2–5 with rather broad basal dark brown bands, 6 and 7 entirely dark. Hypopygium (fig. 2*a*) light; style with a large swelling externally on basal fourth, beyond the swollen portion moderately slender, almost straight, ending beyond middle of coxite, which has a large, pubescent basal lobe. Legs entirely pale yellowish. Front tarsi with slight beard, L.R. about 0·7. No pulvilli. Spur of hind tibia straight, slightly thickened on basal half. Wings

with venation and markings almost exactly as in *P. carnea*. Halteres white. Wing-length 4 mm.

Windermere, vi.1929 (*F.W.E.*). The species was common, but only two males were taken as they were believed at the time to be *Anatopynia punctata*, to which the new species bears a superficial resemblance.

P. carnea (Fab.) (*incurvatus*, Goet.). Fabricius' diagnosis is indecisive, but the specimens in Meigen's collection show that he had the same species as the one named *carnea* by Verrall; some authors have applied the name to different species. The variety *festiva*, Mg. (= *pseudornatus*, Goet.) is larger and darker, with stronger and more extensive wing-markings, but does not differ structurally from the paler typical form, and intermediates occur. Common.

P. hirtimanus (Kieff.) (*barbatipes*, Goet. *nec* Kieff.). A very distinct species by wing-markings, and not subject to much variation. Goetghebuer is probably wrong in his identification of *barbatipes*; Kieffer's description of the wings applies to *P. nubila* but not to the present species. As it is one of the commonest species of the genus with us, it is rather surprising that there appears to be no earlier name. There is an error concerning this species in Goetghebuer's revision: the name *incertus*, Verr. (a manuscript name only, and therefore of no validity), should be placed as a synonym of *hirtimanus*, to which his fig. 69*a* refers.

P. northumbrica, sp. n. ♂. *Head* ochreous, mouth-parts black. Eyes with the dorsal portions narrow. Antennae dark, pale at tip; 15th segment nearly one-third as long as the 14th which is 1·4 times 2–13 together. *Thorax* blackish-grey at sides; scutal stripes dark greyish, almost fused, margins narrowly darker; shoulders and scutellum ochreous. Hair light ochreous. *Abdomen* brownish-ochreous, tergites 1–6 with rather narrow dark brown basal bands, 7–8 all dark; hypopygium pale; styles stout basally, gradually tapering to a sharp point, moderately curved, about two-thirds as long as coxite. *Legs* almost uniformly ochreous, tarsi somewhat darker. Front tarsi without obvious beard, the longest hairs being hardly over twice the diameter. Front L.R. about 0·7, mid L.R. about 0·6. Larger spur of hind tibia straight, stout on about the basal half. No pulvilli; empodium very short. *Wings* (Plate XVII, fig. 1) with the venation of *P. monilis*, and with dark markings (due to black hair) arranged as follows: a dark band near the base, limited *outwardly* by the cross-veins and interrupted below *Cu*, including a still darker spot just below base of cubital fork; three spots in cell R_5, one near the base, one (slightly darker than the others) in the middle, and one at the tip, the first being connected with a dark area over Cu_2 and the second with one below the middle of *M*; dark areas round tips of *M* and Cu_1. Cross-veins not distinctly darkened. Halteres whitish. Wing-length 4 mm. ♀. Wing-markings and other characters as in ♂. Antennae 12-segmented, of the usual form.

Crag Lough, Northumberland, 28.vii.1923 (*F.W.E.*), 1 ♂; Loch Ba, Mull, 3–5.x.1907 (*N. Annandale*), 1 ♀. Differs especially from allied species in the position of the first dark band of the wings before the cross-veins; it is possibly *P. nudipes*, Kieff., which, however, is described as having the costa distinctly produced.

P. nubila (Mg.) (*dubius*, Staeg.; *carneus*, Goet. *nec* Fabr.). Unless I have confused two species under the one name, this is readily known by the two broad dark bands on the wing; there is often a separate dark cloud between the bands over the tip of Cu_2 (?var. *barbatipes*, Kieff.). The second dark band is broader and leaves only the extreme tip of the wing pale; in some (*?unifasci-pennis*, Zett.) specimens it may be very faint, but the darker inner band is

always distinct. The thorax is usually reddish but may be darker. I propose to adopt the name *nubila* (which has not hitherto been recognised with certainty) because *dubius* had been used first by Meigen for another species. Common.

P. pallidula (Mg.) (*?rufus*, Mg.; *?muscicola*, Kieff., 1913*a*; *triannulatus*, Goet.; *quatuorpuncta*, Kieff., 1921*d*). A very distinct species by its yellow colour and the arrangement of the faint wing-markings, the area round the cross-veins being entirely pale. In the female there is usually a small black dot at the anterior end of each of the faintly indicated scutal stripes. The male hypopygium has the basal parts of peculiar structure. Widely distributed; commoner in the north.

P. woodi, sp. n. ♂. *Head* brownish, mouth-parts black. Eyes with the dorsal portion long, narrow, about 3–4 facets wide. Antennae dark, hairs pale at their tips; last segment rather more than one-third as long as penultimate, which is hardly longer than 2–13 together. *Thorax* yellow, pruinose, scutal stripes only slightly darker, hair pale. *Abdomen* whitish; conspicuous dark brown bands at bases of segments 3–6, segments 7 and 8 mainly dark brown. Hypopygium small, yellowish; styles not much shorter than coxites, moderately curved and evenly tapering. *Legs* pale yellowish, but all femora with a narrow dark brown ring close to the tip. Front tarsi without obvious beard; front L.R. about 0·85; mid L.R. about 0·65. Longer spur of hind tibia slender except on basal fourth. No pulvilli; empodium very short. *Wings* with the venation of *P. monilis*; faint markings (due to dark hair) forming a shade over middle of cell R_5, across outer portion of M and Cu_1, and (much more distinctly) over Cu_2. Cross-veins not in the least darkened, and basal part of wing scarcely so. Halteres whitish. Wing-length 4 mm.

Keighley district, Yorks., 2 ♂♂ (*Wood*).

Owing to the faintness of the wing-markings and the distinct abdominal bands, this might easily be confused with *P. nigropunctata*, Staeg., which, however, is rather smaller and lacks the dark femoral ring.

Group D.

Wings quite unmarked. Legs light or dark, but without darker rings, even at tips of femora. R_{2+3} distinctly present and forked. Wing-length 3–5 mm. or more. First segment of mid tarsus shorter than tibia.

Six British species are included here.

1. Body entirely pale yellow . . . . . *melanops*, Mg.
   Body darker . . . . . 2.
2. Pulvilli present . . . . . 3.
   Pulvilli absent . . . . . 4.
3. Legs very long; front tibia nearly 1·5 as long as the femur; ♂ front tarsus without beard; colour darker . . . . . *longimanus*, Staeg.
   Legs normal; front tibia hardly longer than the femur; ♂ front tarsus with moderate beard; colour lighter . . . . . *viator*, Kieff.
4. Legs pale yellow; first six abdominal segments of ♂ mainly yellow; tarsal beard moderate; scutal stripes reddish . . . . . *melanurus*, Mg.
   Whole insect darker; tarsal beard longer . . . . . 5.
5. Scutellum yellow in both sexes; abdomen of ♂ with broad pale bands; postnotum not sharply angled . . . . . *griseipennis*, v.d.W.
   Thorax of ♂ nearly all black (♀ yellow with blackish scutal stripes); abdominal segments of ♂ only narrowly pale posteriorly; postnotum at the end of the median furrow sharply angled, the angle often produced into a slight tubercle . . . . . *barbitarsis*, Zett.

P. melanops (Mg.) (*Ch. interseptus*, Walk.). Entirely creamy-yellow in life, the eyes appearing conspicuously black. About half the females examined have the second antennal segment definitely divided into two, so that 13 segments are present in all. I have found no corresponding differences in the males. Common.

P. longimanus (Staeg.) (*?Psectrotanypus migrator*, Kieff., 1911*a*; *P. longipennis*, Goet.). A rather dark grey-winged species with unusually long legs. Common in hilly districts.

P. viator (Kieff.), 1911*a*. Appears to me to be related to the two following, in spite of its possession of pulvilli. N. Wales (*Verrall, F.W.E.*); Argyllshire (*Waterston*).

P. melanurus (Mg.) (*fuliginosus*, Goet.). It is just possible that this is a variety of *P. nubila* with unmarked wings; the colour of the body and the structural characters are the same in both, and some specimens do seem to show a faint suggestion of wing-bands. Radwell, Herts., and Gormire, Yorks. (*F.W.E.*); Wicken (*Dibb*).

P. griseipennis (v.d.W.) (*murinus*, Goet., 1923*a*). Superficially like *P. longimana*, but readily recognised by the characters noted in the key. I accept Verrall's determination. Slapton, S. Devon (*Verrall*); Quy, Cambs., and Wood Walton Fen, Hunts. (*F.W.E.*); Manchester (*Britten*).

P. barbitarsis (Zett.) (*sordidus*, Zett.; *expalpans*, Walk.; *maxi*, Goet., 1923*a*). Larger and darker than the last, and seems distinct by the shape of the postnotum. Wicken, Cambs.; Mildenhall, Suffolk; Isle of Arran (*F.W.E.*). Kincraig and Loch Fad (*Grimshaw*); Bonhill (*Malloch*).

Group E.

(*Pentaneura*, s. str.; *Peritaphreusa*, Beck.)

Wings and legs quite unmarked. R_{2+3} faint, R_2 indistinct or absent. R_{4+5} ending as usual beyond or above level of tip of Cu_1. Cross-veins approximated. Wing-length 2–3 mm. First segment of mid-tarsus at most as long as tibia.

About 8 British species, some of them rather difficult to separate.

1. Body nearly all yellow (compare *P. melanops*, in Group D) . . . . . 2.
   Body darker . . . . . 3.
2. Dark marks at bases of tergites 6 and 7 in ♂ . . . . . *binotata*, Wied.
   Narrow brown bands near bases of tergites 2–6 . . . *nigropunctata*, Staeg.
3. Legs pale yellow, contrasting with the blackish thorax; ♂ abdomen yellow with black bands on 4 and 5, 7 and 8 all black; ♂ front tarsus bearded *schineri*, Strobl.
   Colour otherwise; ♂ front tarsus not bearded . . . . . 4.
4. Male abdomen ochreous, with brown bands on 3 and 4; 6–8 all dark brown *divisa*, Walk.
   Male abdomen regularly banded on all segments, or unbanded . . . . 5.
5. Thorax with ground-colour green; middle L.R. about 0·7 . *nemorum*, Goet.
   Ground-colour of thorax not green . . . . . 6.
6. Male style sickle-shaped, inserted well before tip of coxite . . . . . 7.
   Male style gently curved or almost straight, and inserted terminally . . 8.
7. Scutal stripes reddish, separate; scutellum yellowish . . . *falcigera*, Kieff.
   Scutal stripes, and often the whole thorax, blackish *falcigera* var. *nigricans*, Goet.
8. Larger (wing about 3 mm.); R_{4+5} longer (about $1{\cdot}7 \times R_1$) and slightly curved; first segment of mid tarsus a little shorter than tibia *cingulata*, Walk.
   Smaller (wing 2–2·5 mm.); R_{4+5} shorter (about $1{\cdot}5 \times R_1$) and almost straight; first segment of mid tarsus fully as long as tibia *brevitibialis*, Goet.

P. binotata (Wied.). Entirely pale yellow, except for the two dark marks on the male abdomen. About half the size of *P. melanops*, with which it might be confused. The ♀ antennae have 13 segments, which are more oval than in *P. melanops*. Common.

P. nigropunctata (Staeg.). Rather larger than *P. binotata*, and with distinct bands on the male abdomen. Female antennae 12-segmented. Lewes, Sussex (*Verrall*); Wicken, Cambs. (*F.W.E.*); Skirwith, Cumberland (*Britten*).

P. schineri (Strobl.). A very distinct species in the male sex, but the female is less conspicuous as it has the abdomen entirely dark. Letchworth and Ickleford, Herts.; Epping Forest; Beesands, S. Devon (*F.W.E.*).

P. divisa (Walk.). As in several other cases, Walker overlooked the cross-vein and referred this species to *Chironomus*. Distinguished from *P. schineri* not only by the lighter thorax, but by having the two dark abdominal bands on different segments, 1, 2 and 5 being entirely ochreous. Three Bridges, Sussex; Matlock, Derbyshire; Llangollen (*Verrall*). Tipton, S. Devon; Teesdale (*F.W.E.*); Arran (*Waterston*); Ilkley (*Grace*).

P. nemorum (Goet.). This is one of the very few species of this subfamily which show a distinct green colour on the thorax, the only other I have noted being *P. ferrugineicollis*. Dart Head, S. Devon; Knebworth, Herts.; Skipwith Yorks. (*F.W.E.*).

P. falcigera (Kieff., 1911*a*). Under this name I include all specimens with the peculiar sickle-shaped subterminal styles figured by Goetghebuer. There is much local variation in colour from specimens with a light reddish thorax and banded abdomen to those which are almost entirely black (var. *nigricans*, Goet.). The fork of R_{2+3} is more distinct than in the others of this group. Common.

P. cingulata (Walk.) (*?pygmaeus*, v.d.W.; *flavoscutellatus*, Goet.). Distinguished from the last by the normal form of the styles, and by the grey pruinescence of the scutum, especially between the stripes. Rather common.

P. brevitibialis (Goet.) (*?ferrugineicollis*, Mg.). In this species, R_{2+3} seems to be entirely lacking, but it is difficult to make sure of this as R_1 and R_{4+5} run very close together. In some specimens the thorax is ochreous with reddish scutal stripes, in others greenish with black scutal stripes and with some grey pruinescence. These latter may perhaps represent another species. Letchworth, Herts.; Epping Forest; Skipwith and Castle Howard, Yorks. (*F.W.E.*); Bollin Valley, Ches. (*A. Dixon*).

Group F.

(*Nilotanypus*, Kieff.)

Wings and legs unmarked. R_{2+3} apparently absent. R_{4+5} ending distinctly before level of tip of Cu_1. Cross-veins rather widely separated. Wing-length 1·5–2 mm. First segment of mid tarsus distinctly longer than tibia.

Only two British species, the second of which has much in common with Kieffer's *Nilotanypus remotissimus*, described from the Sudan. The genus *Nilotanypus*, based on the pubescent eyes and retracted costa, perhaps deserves recognition, but I do not adopt it even as a subgenus because *P. longipalpis* is intermediate between it and *Pentaneura*.

P. longipalpis (Goet.). Scutal stripes buff-coloured, separated by narrow blackish lines; abdomen with pale bands; legs pale. Eyes bare as usual. Segment 14 of ♂ antenna fully as long as 2–13 together. Middle L.R. 1·2.

Base of vein *M* distinct. Palpi long, but not so long as described (the identity of our specimens has been confirmed by Dr. Goetghebuer). Quy, Cambs.; Castle Howard, Yorks. (*F.W.E.*); Ilkley (*Grace*).

P. dubia (Mg.) (*pusillus*, Mg.). Rather than propose a new name, I accept the determination of Haliday for this species, but as Meigen first mentioned it under the name *dubius* this name must be used in place of *pusillus*. This is the smallest species of the subfamily with us, and one of the most distinct. Black with irregular grey pruinescence on scutum. Eyes pubescent. Sixteenth segment of ♂ antennae short (0·7 times 2–13). Base of vein *M* obsolete, the two basal cells not distinctly separated; *m-cu* placed before one-fourth of the wing-length; R_{2+3} appears to be absent. The front legs are the shortest; L.R. of the three pairs 0·8, 1·5 and 1·1 respectively. Common in mountainous regions.

Podonomus, Phil.

(*Ochlus*, End.; *Prosisoplastus*, Kieffer; ?*Lasiodiamesa*, Kieffer.)

The genus *Podonomus* was erected in 1865 by Philippi for a Chilean insect. The diagnosis was very imperfect, and the genus has not been identified till now. In my recent trip to South America I obtained several species of this genus, one of which is almost certainly Philippi's *P. stigmaticus*; it shows the following features :—

Antennae of male plumose, with 15 segments, the penultimate long and distinctly separated from the last. Antennae of female with 12 segments (not 8 as stated doubtfully by Philippi). Palpi normal. Eyes reniform, without dorsal projection. Thorax rather short and rounded. Pronotum reduced, not visible dorsally. Postnotum rather small and rounded without any trace of a median longitudinal furrow or keel. Hypopygium without distinct basal appendages, styles double, both lobes strongly chitinised, their common base much enlarged and hairy. Tibial spurs normal; no tarsal spurs. Fourth tarsal segment a little shorter than fifth, slightly bilobed at the tip. No pulvilli. Wings distinctly hairy towards the tip, and rather broad. R_1 simple in ♂, but very much swollen apically in ♀ (as in *Diamesa*). Basal section of *Rs* distinct and oblique, not transverse as in most other Chironomidae. R_{2+3} absent; R_{4+5} well separated from R_1. Costa much produced. Cross-vein *r-m* shorter than in *Diamesa*, but longer in ♂ than in ♀; *m-cu* joining Cu_1 a little beyond the fork. Squama with long fringe.

All the species of this genus which I found were noteworthy for the fact that they held their wings flat over the back and completely overlapping. On account of this habit they could be readily distinguished in the field from all other Chironomidae, and had rather the appearance of Ceratopogonidae. Perhaps the form of the postnotum (in which the insect also differs from most Chironomidae and resembles the Ceratopogonidae) has some connection with the resting position.

Species of this genus occur in Europe, one or two described by Kieffer under other names belonging here. These species differ from the genotype in their much more hairy wings, and in having 14-segmented antennae in the female, but they resemble *P. stigmaticus* in most other points, and I do not think they should be separated generically.

Enderleins' *Ochlus* from Tierra del Fuego differs only in the bare wings and is probably to be regarded as a subgenus of *Podonomus*.

The name *Prosisoplastus* was introduced by Kieffer (1925*b*) as a subgenus of *Isoplastus*. I consider, however, that it is much nearer to *Podonomus* than to

Pentaneura (*Isoplastus*). The chief feature of the genus is the total absence of R_{2+3}, which is very noticeable owing to the fact that the area between R_1 and R_{4+5} is rather broader than usual, especially in the ♀. In these respects *Prosisoplastus* is similar to *Podonomus* and *Trichotanypus* (type, *posticalis*), and in spite of the fact that in the latter *Cu* forks much beyond the cross-vein while in the former it forks just before it, I am inclined to think that these genera are nearly related.

The type species of *Prosisoplastus* (*P. sphagnicola*, from the eastern Baltic) was known to Kieffer from damaged specimens only. The British Museum possesses a female from arctic Russia (*Dr. E. A. Cockayne*) which most probably belongs to the same species. In this the antennae are unusually long for a Tanypine, with 15 slender cylindrical segments. The wings are conspicuously hairy all over, but the hairs are less dense and close-lying than in most species of *Pentaneura* and *Anatopynia*. Costa reaching far beyond R_{4+5}. R_1 not swollen at tip, and much longer than in *P. peregrinus*. No tarsal spurs. Fourth tarsal segments cylindrical, rather longer than the fifth. No pulvilli.

The single British species is nearer to the genotype.

P. peregrinus, sp. n. ♂. *Head* black, including mouth-parts and antennae. Eyes reniform, the dorsal portion broad. Antennal plumes long but not very dense. Segment 14 only about half as long as 2–13 together; 15 nearly half as long as 14, and about equal in length to 12 and 13 together. *Thorax* and abdomen entirely black, somewhat shining, with yellow hair. *Hypopygium* (fig. 2*b*). Styles of peculiar form, being split into two parts almost to the base; both lobes almost bare, one flattened, with rounded tip, and not much darkened, the other rather longer, curved, sharply pointed and black. Coxites twice as long as styles, somewhat curved, without strong bristles on inner side. *Legs* black, only the trochanters somewhat lighter. Front tarsus without beard; no tarsal spurs. L.R. of front legs about 0·55, mid legs 0·4, hind legs 0·45. Fourth tarsal segment on all legs about twice as long as broad, scarcely half as long as third and rather shorter than fifth, slightly flattened and slightly produced beneath at tip though not bilobed. Claws rather long, blunt-tipped, with a long hair arising from the base of each. No pulvilli. Empodium about half as long as claws. Hind tibial spurs both rather short, without produced point. *Wings* (Plate XVII, fig. 3), greyish, quite unmarked; microtrichia distinct; macrotrichia rather dense and covering the whole surface, dark in colour. R_1 rather over half as long as R_{4+5}; R_{2+3} absent. Costa extending far beyond tip of R_{4+5} and practically reaching wing-tip. Cross-vein *r-m* not very oblique and not much longer than basal section of *Rs*; *m-cu* a little nearer the base and placed immediately beyond fork of *Cu*. Vein *Ax* (second anal) fairly distinct and reaching the margin. Anal lobe hardly distinguishable. Alula scarcely indicated. Squama with several very long hairs. Halteres yellowish. Wing-length 2·2 mm.

Machrie, I. of Arran, 2.vi.1919 (*F.W.E.*), 1 ♂. Differs from *P. sphagnicola* in the antennae and tarsal proportions. Ilkley, Yorks, 1 ♂ (*Grace*).

Kieffer (1924*c*) describes a very similar species as *Syndiamesa* (*Lasiodiamesa*) *gracilis*; if accurately described this species differs from ours in the complete fusion of the last two antennal segments and the much longer fourth tarsal segment. No mention is made of vein R_{2+3}.

One of the most remarkable features of this species is the presence of a distinct axillary vein (second anal, *Ax*), which is complete and reaches the hind margin. Few other Chironomidae show any trace of this vein, and apart from the species under consideration the only Diptera in which it is complete are the

Tipulidae and Trichoceridae. In this case, however, the presence of this vein is not even a generic character, as it is lacking in *P. stigmaticus*.

Another highly remarkable fact about this species is that it appears to be identical with one of those I found in the southern Andes. After carefully comparing British and South American specimens, I can find no difference, unless perhaps the hypopygium of the specimen from Arran has the coxite longer and the pointed style slightly shorter in proportion. If the species is indeed the same it must be presumed to have been introduced into Europe from South America, where it is evidently native, but how this may have happened is at present a mystery. South American females have 12-segmented antennae; wings much broader than in the males and with vein R_1 very much swollen at the tip. Presumably European females will be found to be similar. Another very closely related species, differing chiefly in the proportionate lengths of the antennal segments, occurs in New Zealand.

Anatopynia, Joh.

(Including *Macropelopia*, Thnm., and *Psectrotanypus*, Kieff.)

Wings more or less hairy (densely so in all British species). Costa very distinctly produced; R_2 always present and distinct; *m-cu* placed immediately beyond *fCu*. Antennae of ♀ with 15 segments. Pronotum rather well developed, visible dorsally and hairy above. Minute apical spurs present at tips of first two segments of posterior tarsi Pulvilli present or absent.

The name *Anatopynia*, like several others in this subfamily, was not based upon observation of actual specimens, but merely upon a selection of characters mentioned in published descriptions. In this case the only species originally included by Johannsen was *T. plumipes*, Fries, the chief generic characters mentioned being bare wings and sessile cubital fork. *T. plumipes* must clearly be taken as the genotype, and the diagnosis can be supplemented by an examination of Fries' specimens, of which several exist in the museums of Lund and Copenhagen. In these the wing is not quite bare as described by Fries and assumed by Johannsen, but is distinctly hairy at the tip. The antennae of the ♀ have 15 segments; R_{2+3} is conspicuously forked; and the costa extends well beyond R_{4+5}. The species therefore has all the essential characters of Thienemann's genus *Macropelopia*, with the exception of the reduction of the wing-hair. The amount of hair on the wings is variable in *Procladius*, and this feature provides an insufficient basis for separating *Anatopynia* and *Macropelopia* generically.

Kieffer's *Psectrotanypus* was based on the presence of pulvilli. When first introduced it contained only two species: *varius*, Fabr. (as *brevicalcar*, Kieff.), and *trifascipennis*, Zett. (as *longicalcar*, Kieff.). Both these have 15-segmented antennae in the ♀ and a strongly produced costa. Subsequently other species were added in which the ♀ antennae are 12-segmented and the costa is not produced. I consider that the venational and antennal characters are of more importance than the pulvilli, and consequently would refer the typical species to *Anatopynia*, which they resemble not only in adult characters, but also, as shown by Zavrel, in the larvae and pupae. The remaining so-called *Psectrotanypus* are better placed in *Pentaneura*.

Group A.

(*Anatopynia*, Joh., s. str.)

Wings hairy at tip only; no wing-markings. Pulvilli absent. Large, stoutly built species.

A. plumipes was recorded from Britain by some of the older authors, but probably in error. The specimen named *plumipes* in Stephen's collection is *Chironomus pilicornis*, Fabr.

Group B.

(*Macropelopia*, Tnm.)

Wings rather densely hairy, with at least a dark central spot and usually other markings. No pulvilli.

Five British species belong here. In life they resemble species of *Tanypus* or *Procladius* rather than *Pentaneura* on account of their habit of holding their wings in a roof-like position close to the body, this being specially noticeable in the females. All have dark rings close to tips of femora and bases of tibiae; cross-veins blackened, other wing-markings when present due to dark hair. The figures given by Goetghebuer (*Faune de France*) do not represent the markings very accurately.

A. nebulosa (Mg.). The largest species of the subfamily in Britain. Body dark-coloured, scutal stripes still darker (blackish) and quite distinct. Wings with numerous brown clouds; posterior margin in most specimens narrowly dark, with a row of pale spots before it. An elongate dark cloud below tip of R_{4+5}, and another more rounded one further in cell R_5. Rather common.

A. notata (Mg.) (according to Goetghebuer = *bimaculata*, Kieff.). Rather smaller and lighter than *A. nebulosa*, but still with the scutal stripes rather distinct, dark brown on a greyish-brown ground. Hind margin of wing not continuously dark. Only one dark spot in cell R_{4+5}, the outer one being absent. Local.

A. punctata (Fabr.). Much smaller than the last two. Thorax almost uniformly brownish-ochreous, scutal stripes hardly distinguishable. Wing-spots more rounded and distinct; two rounded spots in cell R_{4+5}, outer one below tip of costa. Local.

A. goetghebueri (Kieff.). A large dark-coloured species somewhat resembling *A. nebulosa*, but wing-markings confined to one blackish cloud over cross-veins; wing-hair all dark. New Forest; Isle of Arran; etc. Common in peaty districts.

A. nugax (Walk.) (*flavipubens*, Goet.; *?rectinervis*, Kieff.). A species of medium size; thorax uniformly brownish-ochreous; abdomen brownish-ochreous with black basal bands on the tergites; wings unmarked except for the black spot over the cross-veins; hair on body and also on wings yellow. Widely distributed but nowhere common.

Variety *subtenuis*, Kieff. (?). Scutum greyish, with indications of four darker stripes; pleurae and postnotum almost black; bands on tergites broader, 6 and 7 all dark. Llangollen and Dolgelley (*Verrall*).

Group C.

(*Psectrotanypus*, Kieff.)

Wings densely hairy, with markings forming bands rather than spots, and when at rest held divaricate. Pulvilli present.

A. varius (Fabr.) (*brevicalcar*, Kieff., 1909). Wings with an irregular band over cross-veins, and another, including some pale spots, on outer half of wing. Common.

A. trifascipennis (Zett.) (*longicalcar*, Kieff., 1909). Wings with three rather regular bands, first before, second beyond cross-veins; third at tip, not including any pale spots. Rather common.

TANYPUS, Mg.

(*Pelopia* (Mg.) Hendel; *Protenthes*, Joh.)

Wings more or less hairy. Costa distinctly produced; R_2 present and very distinct; *m-cu* before *fCu*, distance between cross-vein and base of cubital fork rather less than one-third as long as Cu_2. Antennae of ♀ with 15 segments. Pronotum well developed, hairy above. No tarsal spurs. Fourth tarsal segment on all legs cylindrical. No pulvilli.

At the foundation of the genus *Tanypus* in 1803, Meigen included two species: *monilis*, L. (as *maculata*, Deg.), and *punctipennis*, Mg. (as *cincta*, Fabr.). These two species differ in several important respects, and it is certain that if the old genus is to be divided at all they will have to be placed in different genera. Recent authors, following Johannsen (1908), have treated *monilis* as the type of *Tanypus*, Kieffer claiming that this is necessary because the other species ("*cincta*, Fab.") is unrecognisable. But the following facts are in opposition to this conclusion: (1) Whatever "*cincta*, Fab." may be, it is not in question that the species which Meigen had before him was our *punctipennis*; (2) in his more detailed work published a year later Meigen figures this species only and definitely gives the female antennae as 15-segmented; (3) Latreille in 1810 actually designated *punctipennis* as the type-species; (4) Skuse, who first subdivided *Tanypus*, created a new genus *Isoplastus* for the species with 12-segmented female antennae, the type species of which (*notabilis*, Skuse) is closely related to if not identical with our European *monilis*, a restriction which automatically leaves the name *Tanypus* to *T. punctipennis*; and (5) Johannsen in 1905, the next reviser, erected the genus *Ablabesmyia*, with *monilis* as type, apparently without realising that it was identical with Skuse's *Isoplastus*.

In view of these facts, I consider it necessary to restore the name *Tanypus* to *T. punctipennis* and its allies. Johannsen's change of view in 1908 was occasioned by the fact that Curtis had designated *T. monilis* as the type species, but even if Latreille had not previously indicated *T. punctipennis*, I consider that Curtis' selection of *monilis* was invalid on account of its disagreement with Meigen's original description and figures.

Of *Tanypus* in the sense here used there are but three or four European species, two of which occur in Britain.

T. punctipennis, Mg. Although two other similar species have been described from the Continent by Kieffer, this is readily distinguished from all other British species of the subfamily by the numerous dark spots on the wings; these spots are on the membrane and not due to patches of dark hair as in many species of *Pentaneura*; there is normally a row of five double spots in cell R_5, besides other spots elsewhere. The size and intensity of the spots varies, as does the colour of the body, females often being much lighter. Common.

T. vilipennis (Kieff.). Superficially similar to *Procladius culiciformis*, on account of the black cross-veins and slight dark shade on the outer half of the wing, but venation and antennae as in *T. punctipennis*. A black streak on vein *M* before the cross-veins. Rare. Oxford district (*Hamm.*); Castle Howard, Yorks. (*F.W.E.*); also two old specimens in the British Museum without data.

PROCLADIUS, Skuse.

(Including *Psilotanypus*, Kieff., and *Trichotanypus*, Kieff., part.)

Wings hairy or bare. Costa distinctly produced; R_2 present and very distinct; *m-cu* before *fCu*, distance between cross-vein and base of cubital fork more than half as long as Cu_2. Antennae of ♀ with 13–14 segments. Pronotum well developed, hairy above. Minute apical spurs present on first two segments of posterior tarsi. Fourth tarsal segment on all legs cylindrical. No pulvilli.

The genus *Procladius* was founded by Skuse for two Australian species with a venation similar to our British *T. culiciformis*, L., *i.e.* with a conspicuous fork to R_{2+3} and a long stem to the cubital fork. Although the diagnosis mentioned bare wings as a generic character, this was contradicted by the description and figure of the type species (*P. paludicola*), which indicated a distinctly hairy tip to the wing. No mention of hairs on the wing was made in the description of the second species (*P. pictipennis*), nor are they shown in the figure, but the British Museum possesses examples from Queensland of *P. pentastictus*, Kieff. (which is probably synonymous with *P. pictipennis*), and these have a few hairs at the wing-tip and also in the anal cell. It would therefore appear that in distinguishing *Procladius* by the character of bare wings Kieffer was not strictly accurate. Skuse did not mention the tarsal structure and only described the male; the examples of *P. pentastictus* referred to show a cylindrical fourth tarsal segment and 13-segmented antennae in the female.

Psilotanypus was first introduced by Kieffer for a number of bare-winged species with a venation similar to *Procladius*, but said to have the vein R_2 absent. It would seem, however, that Kieffer relied for his diagnosis on the published descriptions and had not examined any of the species, except perhaps *P. rufovittatus*, in which R_2 is present. Most of the other species included were stated by Kieffer to be insufficiently described and their position in the genus doubtful; * several of these have since been shown to belong to the *Diamesa* group. The generic definition therefore has to be amended, and when this is done the only character remaining to separate it from *Procladius* is that of the completely bare wings. Since typical *Procladius* have the hairs present only at the extreme tip of the wing I hardly think this difference sufficient for generic separation of the two groups.

Trichotanypus when first proposed by Kieffer included only one species, *T. posticalis*, Lundbeck, from Greenland. Subsequently he added the European *T. culiciformis*, L., and allied species, and based his conception of the genus on these. But according to the original description *T. posticalis* is peculiar in having no trace of the vein R_{2+3}. Johannsen, who has re-examined the type, states (*Can. Ent.*, 1926, p. 99) that this description is quite correct; he therefore considers that *T. culiciformis* and its allies, which have R_{2+3} well developed and forked, should be removed from *Trichotanypus*. With this I agree, but think they are more nearly related to *Procladius* than to *Tanypus* (*Protenthes*). Among the European species we find a gradual series from those with wings hairy only towards the tip (hardly more so than *T. paludicola*) to those which are densely hairy all over; I therefore prefer to include all these species in *Procladius*.

* Among those so designated by Kieffer was *T. bellus*, Lw. I therefore consider that Coquillett was not justified in selecting this as the genotype, and would suggest *T. rufovittatus*, v. d. Wulp, instead. From the description these two species appear to be nearly related.

A convenient, but perhaps hardly natural division of the genus will be into those with completely bare wings and those with some hairs present on the membrane. I propose to recognise provisionally on this basis the two subgenera *Psilotanypus* and *Procladius*.

Subgenus **Procladius**, Skuse (emended).

Wings hairy, at least at tip.

Four British species, all very similar structurally, differing mainly in colour and size. In all of them the female antennae have 14 segments, but this is not true of the whole subgenus, because apart from the Australian species mentioned above, Kieffer describes some European species which have only 13 segments. In his synopsis (1924*a*) he probably grossly exaggerates the number of European species.

P. crassinervis (Zett.). Almost completely black, including legs and often also *halteres of* ♂; thorax of ♂ slightly shining; shoulders and halteres of ♀ yellowish. A.R. fully 2·5. Tarsal beard slight. Outer lobe of ♂ style long, not much shorter than inner, which is more sharply pointed than in the other species. Wings with rather scanty hair, confined in ♂ to outer half of wing, except for a few hairs in anal cell; ♀ wing as usual rather more hairy. Cross-veins blackened; a slight dark shade across outer half of wing. Rostherne, Cheshire (*Britten*); Corrour, Inverness and Loch Fad, Bute (*Grimshaw*).

P. choreus (Mg.) (*Ch. incomptus*, Walk.). Not so dark as the last. Halteres, shoulders and scutellum usually pale in both sexes, though the male scutellum is often darkened; ♀ often much paler than ♂; A.R. varying 1·6–2·0. Tarsal beard short but distinct. Outer lobe of ♂ style about 2 × 1. Wings with rather dense hair. Cross-veins blackened; a dark shade across outer half of wing and often slight indications of a dark patch in anal cell. Rather variable in size, colour, and hairiness. Wing-length 2·5–4·5 mm. Common.

P. culiciformis (L.). Perhaps only a variety of the last, the hypopygium being identical in structure. Size smaller (wing-length about 2 mm.). Wing-markings more distinct, the anal cell with a distinct spot; tip of wing rather conspicuously pale. A.R. about 1·5. Tarsal beard apparently absent. Widely distributed and rather common.

P. sagittalis (Kieff.). Differs from the last two in the wings, which are more densely clothed with dark hair; the outer half thus appears greyish, though it lacks the dark shade on the membrane which is always present in the other species. Outer lobe of ♂ style very small, scarcely as long as broad. No tarsal beard. This is undoubtedly Kieffer's *sagittalis*; it also agrees with Meigen's description of *choreus* and is (in part at least) the species so recorded from Britain. Kieffer's *choreus* does not seem to me to be well distinguished from *culiciformis*. Radwell, Herts. (*F.W.E.*); Manchester (*Britten*); Arran (*Waterston*); Oxford (*Hamm*). Perhaps overlooked elsewhere through confusion with *culiciformis*.

Subgenus **Psilotanypus**, Kieff. (emended).

Wings quite bare, even at extreme tip.

In this subgenus we have three British species, which are alike in all structural features, but differ rather conspicuously from one another in colour. In all of them the antennae of the female have only 13 segments.

P. rufovittatus (v. d. Wulp). (*albinervis*, Kieff.; ? *bathyphilus*, Kieff., 1922*a*). Scutum light yellow, with four sharply defined dull stripes, middle pair narrowly separated; these stripes black in ♂, black or red in ♀. Abdominal tergites broadly pale posteriorly. Legs mainly pale. Cross-vein *r-m* more or less dark, *m-cu* pale. Kensington (*Austen*); Ruislip, Middlesex (*F.W.E.*); Castlebar Lough, Ireland (*Grimshaw*); Reddish, Lancs. (*Britten*).

P. lugens, Kieff. Thorax entirely black and rather shining, except for the pale yellow pleural membrane. Head, abdomen and legs also almost uniformly blackish. Cross-veins darkened, especially the anterior, which is black. Our specimen differs from Kieffer's description (of ♂ only) in having the L.R. about 0·7 instead of 0·5. Timworth, Suffolk, 1 ♀ (*Nurse*).

P. flavifrons, sp. n. Thorax shining black as in *P. lugens*, but head with a large creamy yellow patch on front above antennae, and all tibiae with broad yellowish-brown rings in middle, only base and tip blackish; first segment of each tarsus also mainly brown, lighter in ♂ than in ♀, and lightest on hind legs. Cross-veins darkened, as in *P. lugens* (text-fig. 1). Size smaller, wing-length 2 instead of 3 mm. Lake Windermere, 4 ♀ taken on windows of steam launch, vii.1923 (*F.W.E.*). Waterville, Ireland, 1 ♂ in Dublin Museum (*Yerbury*).

Clinotanypus, Kieff.

Wings quite bare. Costa strongly produced; R_2 present and very distinct, but disconnected from R_{2+3} and appearing as a free branch of R_1; *m-cu* before *fCu*, distance between cross-vein and base of cubital fork more than half as long as Cu_2. Antennae of ♀ with 14 segments. Pronotum forming a distinct collar. Postnotum with fine pubescence. Small tarsal spurs present. Fourth tarsal segment of each leg shorter than fifth and cordiform.

There are numerous species in the tropics, but only one in Europe.

C. nervosus (Mg.). A stoutly-built, shining black insect of rather large size; wings unmarked. Locally abundant.

Subfamily DIAMESINAE.

The genus *Diamesa* and its allies are at least as closely allied to *Orthocladius* as to *Tanypus*, but they have some special features of their own, and it seems best to treat them as forming a separate intermediate group which may be defined as follows :—

Cross-vein *m-cu* present. R_{2+3} always present and distinct, ending in costa well beyond R_1, with which it is not connected, R_2 being absent. Wings usually quite bare. Male antennae with 13–14 segments, of which the last is the longest; rarely there are traces of a minute globular segment incompletely separated at tip of last segment. Female antennae with 6–8 segments, rarely 14. Pronotum well developed, rarely divided in middle. Front tibia with a distinct spur. Middle tibiae with two spurs; hind tibiae with two spurs and a comb.

A number of divisions of the old genus *Diamesa* have been proposed by Kieffer, some of which I am willing to accept, although I would define them somewhat differently, and do not attach much importance to the presence or absence of pubescence on the eyes.

The four genera or subgenera so far found in Britain may be distinguished as follows :—

1. Cross-vein *m-cu* placed a little before *fCu* (Plate XVII, fig. 6) . . *Prodiamesa*.
   Cross-vein *m-cu* placed a little beyond *fCu* (Plate XVII, figs. 4–5) . . . 2.
2. Pronotum hairy all over; antennae of ♀ with 14 segments . . *Protanypus*.
   Pronotum bare above; antennae of ♀ with 6–8 segments . . . . . 3.
3. Fourth tarsal segment cylindrical, as long as the fifth or longer; wings greyish . . . . . *Syndiamesa*.
   Fourth tarsal segment more or less cordate (at least on the posterior legs) and shorter than the fifth . . . . . *Diamesa*.

Four Palaearctic genera have not yet been recognised in Britain :—

Monodiamesa, Kieff. (1922*b*). Said to differ from *Prodiamesa* only in having the male styles simple and wings without microtrichia.

Potthastia, Kieff. (1922*b*). According to the description, resembles *Diamesa*, Group C (= *Psilodiamesa*), but has the first segment of the front tarsus a little longer than the tibia.

Trichodiamesa, Goet. (1926). Venation and tarsal characters as in *Psodiamesa*, but wings densely hairy.

Heptagia (Phil.), Edw. (1928*b*). Cf. Group C of *Diamesa*, but tibiae with white rings in both sexes; pronotum divided and lobes more or less separate; scutal hairs reduced or absent; antennal plume of ♂ reduced. The species are found running on rocks about waterfalls.

Protanypus (Kieff.), Edw.

(*Didiamesa*, Kieff., 1924*d*.)

Eyes bare, widely separated in both sexes. Antennae of ♂ with 14 segments, usually also with traces of a minute 15th segment, but this is rarely completely separated and is variable individually, 14th segment longer than the remainder. Pronotum conspicuously hairy. Male hypopygium with tips of coxites produced beyond insertion of styles, latter simple. Fourth tarsal segment cylindrical and as long as fifth. Wings without macrotrichia or distinct microtrichia; *m-cu* placed a little beyond base of cubital fork.

This genus is intermediate between the Tanypodinae and Diamesinae, but is placed here on account of the venation. There are two or three species in northern Europe.

P. morio (Zett.). A black species with slightly milky wings; legs short-haired, front tarsus in ♂ without beard. Loch Tummel, Pitlochry, Perth (*M. E. Mosely*); Corrour, Inverness (*Grimshaw*); Windermere (*F.W.E.*).

Syndiamesa, Kieff.

Eyes bare. Antennae of ♀ with 7–8 segments. Pronotum bare. Male styles simple. Fourth tarsal segment cylindrical, at least as long as fifth. Front as well as mid and hind tarsi with minute apical spurs on each of the first three segments. Wings greyish, with small microtrichia and sometimes a few macrotrichia at the tip; *m-cu* placed a little beyond base of cubital fork.

This genus was erected by Kieffer (1918*a*) for five species, of which the type may be taken as *Diamesa hygropetrica*, Kieff.; it is doubtful whether all five (e.g. *S. albipennis*, Kieff.) belong to the same group; I do not know any of them. The genus is close to *Diamesa* (Group B), differing almost solely in the form of the fourth tarsal segment.

S. pilosa, Kieff., 1924*c*. A rather large blackish species, differing from all the other Diamesinae known in Britain by the presence of macrotrichia at the tip of the wing, in cells R_5 and M (Plate XVII, fig. 5); the hairs more numerous

in ♀ than in ♂. Wings with lobe almost right-angled; *r-m* straight, oblique; *m-cu* before *r-m*. Front tarsi without beard. Fourth tarsal segment as long as fifth. Hypopygium with rather long anal point; style large; no distinct basal lobe. Keighley (*Wood*).

S. (?) chiron (Hal.). According to Haliday's description the type (from Belfast) has the fourth tarsal segment cylindrical and about twice as long as the fifth; front tarsi of ♂ with long beard. No further specimens have been found in Britain, and the type is unfortunately lost. The hypopygium (as figured by Goetghebuer) is peculiar.

Diamesa, Mg.

(Including *Adiamesa*, Kieff., and *Psilodiamesa*, Kieff.)

Eyes pubescent or bare. Antenna of ♀ with 7–8 segments, of ♂ without trace of 15th segment. Pronotum bare, or only slightly hairy at sides. Male styles simple, tip of coxites not prolonged. Fourth tarsal segment (at least on posterior legs) shorter than fifth and more or less cordiform or bilobed at tip. Cross-vein *m-cu* placed a little beyond *fCu*; *r-m* long and usually curved.

We have about ten British species, which may be arranged in three groups, distinguished thus :—

1. Eyes pubescent; wings grey . . . . . *Group A.*
   Eyes bare . . . . . 2.
2. Wings grey, with fine microtrichia . . . . . *Group B.*
   Wings white, without microtrichia . . . . . *Group C.*

Group A.

(*Diamesa*, Mg., s. str.; *Eutanypus*, Coq.; *Adiamesa*, Kieff.)

Eyes densely pubescent. Front as well as middle and hind tarsi with minute apical spurs on each of the first two segments. Fourth tarsal segment of middle and hind legs (as seen from above) rather broad, constricted beyond middle and bilobed at tip, always shorter than fifth. Wings greyish, with distinct microtrichia visible under a magnification of 300. Lobe large, right-angled.

Kieffer's genus *Adiamesa* was founded solely on the reduction of the plume of the male antennae, which I do not regard as a sufficient generic distinction; as noted below, the degree of reduction of the plume is variable in our British species. I have examined the type of Coquillett's genus *Eutanypus* in the Washington Museum, and find it to be a *Diamesa* closely related to *D. culicoides*.

D. culicoides, Heeger (*tonsa*, Hal.; *pergens*, Walk.; *pertractus*, Walk.). Pronotum usually ochreous, slightly hairy at the sides. Male antennae only very slightly plumose, A.R. about 0·3. Style broad basally, suddenly narrowed on the apical half. Thorax dark grey, pruinose, scutal stripes not well marked. Legs dark. Rather common. This species runs rapidly in a peculiar zig-zag manner.

Variety? Hypopygium quite as in the type, but male antennae rather more plumose, A.R. about 0·7; pronotum blackish. Hexton, Herts., 1 ♂ (*F.W.E.*).

D. waltli, Mg. As Meigen only described the female, the interpretation of this name is open to some doubt. I use it for a species with the hypopygium as in fig. 2*d*. It resembles *D. culicoides* in most respects, but can usually be

distinguished by the blackish pronotum. In the ♂ the antennae are plumose, A.R. more than 1. Hypopygium with very long and stout anal point, long basal appendages which are densely hairy at the tip, and rather short styles. I have seen only one British male, from Whernside (*F.W.E.*).

D. prolongata, Kieff. Differs from *D. waltli* only in the hypopygium (fig. 2*h*), which is shorter; basal appendages long and slender, but almost bare, not more than two or three short hairs at the tip; styles long, with median swelling on inner side. Skegby, Notts. (*Carr*); Dreghorn, Ayrshire, and Isle of Arran (*F.W.E.*); Ilkley (*Grace*).

Group B.

Eyes bare. Legs and wings as in Group A.

The three species noted below would probably have been referred by Kieffer to *Psilodiamesa*, on account of the bare eyes, but they are obviously more nearly related to Group A (*Diamesa*) than to Group C (*Psilodiamesa*).

D. incallida (Walk.) (*nexilis*, Walk.). Fourth tarsal segment as in *D. culicoides* and *D. waltli*, with distinct constriction beyond the middle. Male antennae plumose, A.R. about 1·5. Colour almost as in *D. waltli*. Hypopygium (fig. 2*j*): No distinct anal point. Style rather broad and almost bare. Basal lobe not separated from the coxite, but extending to over two-thirds of its length. Apart from Walker's types (both ♂) I have seen only 1 ♀ which may belong to this species, from Lelant, Cornwall (*Yerbury*).

D. latitarsis, Goet. This was described only from the ♀, and until the ♂ is obtained in the type locality the identity of the species must remain uncertain. I provisionally refer to it a male which is very much like *D. incallida*, having bare eyes as in that species, but is smaller, and has quite a different hypopygium (fig. 2*e*), resembling that of *D. prolongata*: anal point rather long and slender; basal appendage long, slender, bare, separate from the coxite; style long and not very broad. Scutal stripes rather less pollinose than in the other species, the spaces between them more whitish-grey. Whernside (*F.W.E.*).

D. permacer (Walk.). A.R. 1·0; penultimate segment quite twice as long as broad; tip of last segment strongly clubbed. Fourth tarsal segment shorter than the fifth, but almost cylindrical on the front legs; slightly cordiform on the posterior legs, but without constriction beyond the middle. Hypopygium (fig. 2*c*) much as in *D. incallida*, without distinct anal point or basal lobe; style moderately broad. Only known from Walker's type.

Group C.

(*Psilodiamesa*, Kieff.)

Eyes bare. Fourth tarsal segment much shorter than the fifth; on the posterior legs distinctly cordiform and with constriction beyond the middle. Front tarsi without spurs. Wings milky-white; no microtrichia. Anal lobe larger than in Groups A and B, more or less produced.

The name *Psilodiamesa* was introduced by Kieffer (1918*a*) for *P. spitzbergensis*, which was said to have *r-m* short and vertical, *m-cu* long and oblique. Since the reverse is the case in all other Diamesinae, I am inclined to suspect that this was merely a *lapsus calami* of Kieffer's in preparing the original description of *P. spitzbergensis*, and that he afterwards copied the mistake

from his manuscript in compiling his key to the genera of the *Diamesa* group. All species here mentioned have normal venation similar to that of *D. waltli*.

D. inscendens (Walk.). Antennae of ♂ with whitish plume, A.R. about 1·5; of ♀ ochreous, 7-segmented. Thorax somewhat shining, with scarcely a trace of pruinescence. Scutal stripes blackish and fused in ♂, light to dark

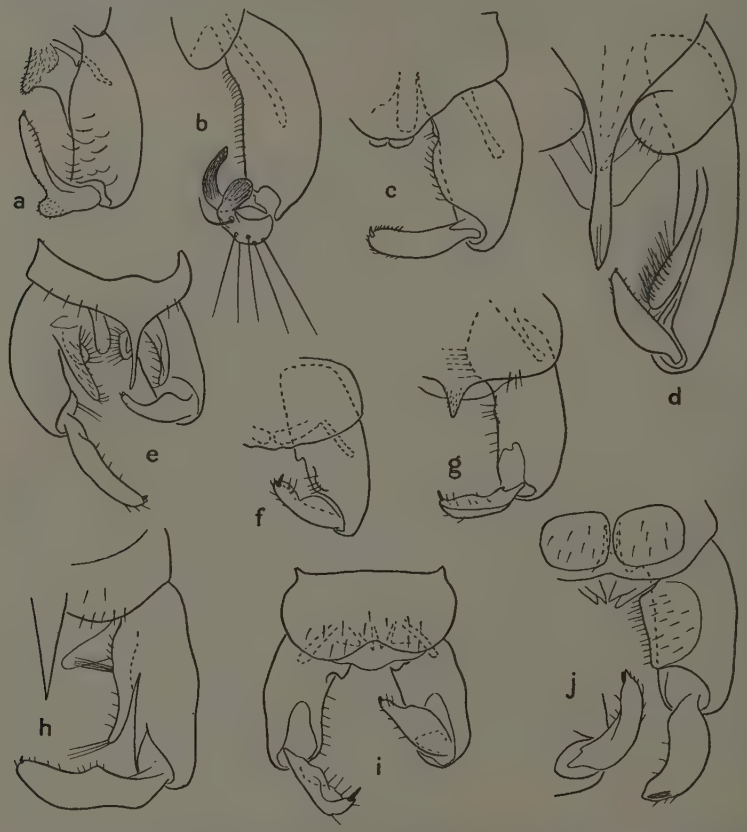

Fig. 2.—♂. Hypopygium, from above, of: a, *Pentaneura fusciceps*, sp. n. b, *Podonomus peregrinus*, sp. n. c, *Diamesa permacer*, Walk. d, *D. waltli*, Mg. e, *D. latitarsis*, Goet. f, *D. inscendens*, Walk. g, *D. montium*, sp. n. h, *D. prolongata*, Kieff. i, *D. campestris*, sp. n. j, *D. incallida*, Walk.

brown and separate (sometimes absent) in ♀; ground-colour of thorax ochreous in ♀. Abdomen blackish in ♂; tergites in ♀ dark brown with paler hind margins; venter of ♀ green in life. Hypopygium (fig. 2*f*) not very strongly chitinised; no anal point nor basal lobe; style emarginate on inner side beyond middle. Femora dark brown in ♂, indistinctly paler at base; in ♀ the posterior femora are ochreous with dark brown tips. Front tibia dark brown, indis-

tinctly paler in middle; posterior tibiae whitish-ochreous (paler in ♀ than in ♂, and whiter in life), dark brown at each end; tarsi dark brown, paler at the base. Halteres white. Wing-length 3–3·5 mm.

Common by mountain streams; Derbyshire to Sutherland.

This is quite possibly Meigen's *D. gaedii*, but there are some discrepancies: according to Meigen the last segment of the ♀ antennae is black, the rest yellow; abdomen yellow with dark dorsal line; wings hyaline.

D. lacteipennis, Zett. (*typhon*, Hal.). Similar to *P. inscendens*, but thorax heavily pruinescent; plumes of ♂ antennae darker; posterior tibiae more ochreous-brown; hypopygium more strongly chitinised and differing slightly, a very short anal point being present. Wing-length 3·5–4 mm. Blakeney Point, Norfolk (*Dr. W. E. Brenchley*); Holker Moss, N. Lancs. (*F.W.E.*); Cork (*Haliday*); Skirwith, Cumberland (*Britten*); Ilkley? (*Grace*).

A ♂ from the New Forest (*Sharp*) is similar, but has all femora conspicuously yellow at base, and the four posterior femora also rather extensively brownish-yellow on the upper surface, leaving a dark patch beneath towards base.

D. galactoptera, Now., as redescribed by Goetghebuer (1922) is evidently nearly related to this species, differing in having the ground-colour of the ♂ thorax yellow.

D. ammon, Hal. According to Haliday's description this differs chiefly if not solely from the last species in having 8-segmented antennae in the ♀. It is possible that this is only a matter of individual variation. I have not seen a specimen. Sand-hills on Irish coasts (*Haliday*).

D. campestris, sp. n. Thorax and abdomen of ♂ black, scutum with very slight pruinescence. Hypopygium (fig. 2*i*): style differing slightly in shape from the last two, terminal spine longer; no anal point. Antennal plume largely pale, A.R. nearly 2. Legs blackish, posterior tibiae more brownish. Halteres light to dark brown. Staines, Middlesex (*Austen*); Ilkley, Yorks. (*Grace*); Dreghorn, Arran (*F.W.E.*); Cambridge (*Jenkinson*).

D. montium, sp. n. Body and legs practically all black, thorax with very slight pruinescence. Hypopygium (fig. 2*g*): style quite differently shaped from the other species; anal point present, conical. Antennal plume black except at tip, A.R. about 2. Wing as in Plate XVII, fig. 4. Halteres rather dark brown. Arran and Ingleborough (*F.W.E.*).

PRODIAMESA, Kieff.

Eyes bare. Antennae of ♀ with 6–7 segments. Pronotum bare. Male hypopygium with styles double. Fourth tarsal segment on all legs cylindrical and longer than fifth. Wings greyish, with very small microtrichia; *m-cu* placed distinctly before base of cubital fork.

There is probably only one British species, which has been described many times over under either *Tanypus*, *Chironomus* or *Diamesa*.

P. olivacea (Mg.) (*scutellata*, Mg.; *notata*, Staeg.; *consobrinus*, Zett.; *nudipes*, Zett.; *convestitus*, Walk.; *obditus*, Walk.; *perpessus*, Walk.; *praecox*, Kieff.; *ichthyobrota*, Kieff.). Brownish; scutum somewhat shining, with three dark brown to blackish stripes, which are usually fused in ♂ but separate in ♀. There appear to be two forms of the ♀, one with 6-segmented antennae (second segment only slightly constricted), the other with 7 (second segment completely divided). No differences have been found in the males to correspond with these two forms. Common everywhere.

Subfamily ORTHOCLADIINAE.*

In this subfamily I would include Kieffer's group Orthocladiariae and also some genera referred by him to the Clunionariae. The chief characters of the subfamily are the following :—

Eyes reniform. Front usually with a median longitudinal furrow. Face well developed and hairy. Male antennae usually plumose and normally composed of 14 segments; female antennae with 5–8 segments (usually 6) and provided with sense-bristles. Pronotum usually forming a distinct collar, never divided into separate lateral lobes, even in the wingless species. Postnotum with the median furrow or keel distinct. Suture between sternopleurite and anepisternite well marked and reaching forward almost to front coxa. Hypopygium not inverted; styles movable, folded inwards in repose, and with a distinct terminal spine (except in *Eurycnemus* and *Brillia*); basal lobes never finger-like with long recurved hairs. Front coxae not enlarged. Front tibia always with a distinct spur. First segment of front tarsi shorter than the tibia. Middle tibiae usually with two short spurs, but without comb. Hind tibiae normally with two spurs, the outer always much shorter than the inner, and often very minute, perhaps sometimes absent; inner spur rather long. On inner side of hind tibiae adjacent to the spur a comb of free spinules or fine bristles is nearly always present. Venation: *m-cu* absent; R_{2+3} usually distinct, never connected with R_1 by a cross-vein; costa very often produced beyond tip of R_{4+5}.

The subfamily is a very large one, showing a fair amount of diversity among its members. Its classification is a matter of great difficulty and is not yet satisfactorily established, owing to the lack of clear dividing lines. Of the characters made use of by Kieffer, those drawn from the pulvilli and empodium have been proved to be of little importance for defining genera, and the same may be said of the palpi and the pubescence of the eyes. On the other hand, the presence or absence and the extent of the squamal fringe, and the position of the tip of R_{2+3} are useful features, although these also cannot be used without caution.

The British genera I propose to recognise may be distinguished thus :—

1. Wing-membrane with macrotrichia, at least at the tip . . . . . 2.
   Wing-membrane devoid of macrotrichia . . . . . 5.
2. Cross-vein *r-m* very long and oblique (Plate XVII, fig. 7); male styles bifid; small pulvilli present . . . . . 3.
   Cross-vein much shorter; male styles not bifid . . . . . 4.
3. Scutum conically produced in front; wings spotted . . . . *Eurycnemus.*
   Scutum not conically produced; wings unmarked . . . . . *Brillia.*
4. Wing-hairs decumbent (Plate XVII, figs. 8–12); pulvilli absent . *Metriocnemus.*
   Wing-hairs suberect (Plate XVIII, figs. 2, 3); small pulvilli present *Spaniotoma apicalis.*
5. R_{4+5} completely fused with the thickened costa, and reaching to at most two-thirds of the wing-length; a false vein running close to anterior margin on outer half of wing (Plate XIX, figs. 1–5) . . . *Corynoneura.*
   R_{4+5} not completely fused with the costa, and reaching to at least three-quarters of the wing-length; if (rarely) it is slightly shorter, there is no false vein near anterior margin beyond costa . . . . . 6.

* I propose to follow Kieffer's usage in deriving the subfamily name from *Orthocladius*, even though that genus is sunk as a subgenus of the earlier *Spaniotoma*.

6. Dorso-central hairs of thorax minute and decumbent; tibiae usually with white rings; eyes densely pubescent . . . . . *Cricotopus.*
   Dorso-central hairs distinct, suberect, arising from obvious punctures; tibiae unicolorous; eyes usually bare 7
7. Fourth segment of posterior tarsi cordiform, shorter than fifth. . *Cardiocladius.*
   Fourth segment of all tarsi cylindrical, usually as long as or longer than fifth . . . . . *Spaniotoma.*

The following European genera have not been found in Britain, but one or two of them should occur in Scotland or elsewhere; the validity of the others is doubtful.

Hydrobaenus, Fries (*Psilocerus*, Ruthé). Differs from *Orthocladius* in having no distinct plume on ♂ antenna. Pronotum large; legs stout; fourth tarsal segment much shorter than the fifth, but not cordiform(?). Hind tibial comb present(?). Palpi 4-segmented but short. Male hypopygium (according to figure) without basal appendage.

Propsilocerus, Kieff. (1923*c*). Similar to *Hydrobaenus* (possibly synonymous), but said to differ in having no comb on hind tibia; palpi with 3 segments only; and ♂ coxite with a long basal appendage. *Synpsilocerus*, Kieff., is probably synonymous.

Trissocladius, Kieff. (1908*a*). Differs from *Orthocladius* mainly if not solely in having only 3 segments in the palpi. Of the two species originally described, *T. brevipalpis* may be regarded as the genotype, and has normal plumed antennae; *T. heterocerus* has the plume reduced.

Symbiocladius, Kieff. (1925). Eyes, antennae, wings and tarsal characters as in *Orthocladius*, Group C; but palpi with three segments only, the last two almost fused and each scarcely twice as long as broad, and hind tibia without comb. According to Kieffer the hind tibiae have two unequal spurs, but a cotype ♀ received from Prof. Zavrel and other specimens sent me from Roumania by M. Codreanu have only one longish spur. In the Roumanian species, which appears to be identical with *S. rhithrogenae*, Kieff., the ♂ has normal plumed antennae, A.R. about 1; hypopygium without anal point; styles rather long and broad, without subapical lobe; basal lobe large and squarish, not free; fourth segment of posterior tarsi shorter than fifth, but not so short as in ♀, and not at all cordiform. The larvae are parasitic under the wing-pads of May-fly nymphs of the genera *Rhithrogena* and *Ecdyurus*.

Eurycnemus, v.d.W.

Eyes bare, with rather long and narrow dorsal extensions. Antennae of ♂ with 14, of ♀ with 7 segments. Pronotum fairly well developed, but covered over by a forward extension of the scutum, which is almost pointed in front. Coxite of ♂ with a long, bare basal appendage, styles forked, without terminal spine. Femora and tibiae appearing rather thick, chiefly on account of dense hair. Hind tibia without comb; spurs subequal and rather long. Pulvilli present. Wings rather densely hairy all over, the hair dark in places, forming rather definite markings. Cross-vein *r-m* very long and curved. Squama fringed.

E. crassipes (Panz.) (*elegans*, Mg.; *aestivus*, Curt.; *hirtipes*, Macq.). A large greenish-yellow species; thorax with some small black spots; legs yellowish; knees and tarsal joints dark. Few recent records: Shrewsbury (*Burton*); Ilkley (*Grace*); Rydal (*F.W.E.*).

Goetghebuer accidentally omitted to show the fork of the style in his figure of the hypopygium.

Brillia, Kieff.

Eyes bare. Antennae with 14 segments in ♂, 6 in ♀. Pronotum forming a distinct collar, but just divided in middle. Scutum not produced in front. Hypopygium of ♂

(fig. 3*a*) with bare basal appendage and forked styles, as in *Eurycnemus*. Legs rather slender; spurs and hind tibial comb normal, outer spur rather shorter than inner. Pulvilli present, though very small. Wings rather densely hairy, but the hair uniform in colour. Cross-vein *r-m* (in the British species) long and curved (Plate XVII, fig. 7). Squama fringed.

This genus is intermediate between *Eurycnemus* and *Metriocnemus*, agreeing with the former in the structure of the hypopygium, presence of pulvilli, and venation, but with the latter in the form of the thorax and lack of ornamentation. There are two British species.

B. longifurca, Kieff., 1921*d*. A rather large species. Scutum yellowish with dark brown or black stripes; abdomen dark brown, hind margins of tergites broadly paler. Outer branch of male style (fig. 3*a*) very long, more than twice as long as inner. L.R. about 0·85. Locally common: Watford and Hitchin, Herts.; Church Stretton, Salop (*F.W.E.*); Didsbury and Denton, Lancs. (*Britten*); Bowhill, Dumbarton (*Malloch*).

B. modesta, Mg. (*sylvestris*, Goet.; ? *bifida*, Kieff.; ? *petrensis*, Kieff., 1913*a*). Somewhat smaller than the last (average wing-length barely 3 mm.); abdomen uniformly brown in both sexes, and male styles with the two branches subequal in length. Colour variable; darker specimens (chiefly ♂) have scutal stripes black and more or less fused, scutellum black; others have the scutal stripes brown and well separated, scutellum yellow. Common.

The species recorded as *Metriocnemus modestus* from Clare Island by Grimshaw would appear from his figure to be *Pentapedilum sordens*, v.d.W.

Metriocnemus, v.d.W.

Wings with distinct macrotrichia, at least at the tip; *r-m* rather short. Eyes bare (except in *M. gracilis*). No pulvilli. Pronotum forming a distinct collar; scutum not produced in front. Male styles not bifid. Hind tibia with comb as usual; outer spur much shorter than inner.

This genus, even after the exclusion of *Brillia*, still includes nearly all the hairy-winged Orthocladiinae. Coquillett chose *albolineatus* as the genotype, but as no one knows what van der Wulp understood by this name, and Meigen's types are a mixed series belonging to more than one genus, it may be as well to ignore this designation and regard *fuscipes*, Mg., as the genotype. We have about 18 British species, which may be arranged in six groups; these groups are so distinct that they should probably be regarded as separate subgenera, but names are not available for all of them and I refrain from proposing any.

Key to Groups.

1. Hind L.R. 0·55 or less; R_{2+3} ending near R_1; costa produced (Plate XVII, fig. 10) . . . . . 2.
   Hind L.R. 0·6 or more; R_{2+3} usually ending well beyond R_1 . . . . . 3.
2. Eyes bare . . . . . *Group A.*
   Eyes pubescent . . . . . *Group B.*
3. Costa ending abruptly at tip of R_{4+5}, which reaches beyond level of tip of Cu_1 (Plate XVII, fig. 8) . . . . . *Group C.*
   Costa more or less produced, R_{4+5} shorter . . . . . 4.
4. R_{4+5} ending well before tip of Cu_1; squama more or less fringed (Plate XVII, figs. 11, 12) . . . . . *Group D.*
   R_{4+5} ending above or scarcely before tip of Cu_1 . . . . . 5.
5. Squama partially fringed . . . . . *Group E.*
   Squama quite bare (Plate XVII, fig. 9) . . . . . *Group F.*

Group A.

(*Metriocnemus*, s. str.; ? *Wulpiella*, Kieff.; ? *Gripekovenia*, Kieff., 1918*b*.)

Eyes bare as usual. First two hind tarsal segments with small apical spurs (except in *M. gracei*). Front L.R. about 0·65, hind L.R. 0·55 or less. Femora rather thick. Empodium usually quite short. Costa very distinctly produced. R_{2+3} running close to R_1; R_{4+5} ending before level of tip of Cu_1; *r-m* oblique. Stem vein with numerous long hairs. Squama with complete fringe. Body generally all black, at least in ♂. Hypopygium with long, bare anal point.

About half our species belong to this group, which includes most of the larger species; some are difficult to distinguish.

1. Wings densely hairy all over (less so in *M. picipes*, ♂) . . . . . 2.
   Wings hairy at the tip only . . . . . *tristellus*, sp. n.
2. Wing-hair greyish or dark . . . . . 3.
   Wing-hair whitish, halteres brown to yellow . . . . . *atratulus*, Zett.
3. Halteres and mesonotal hair black, at least in ♂; ♀ thorax all black . . 4.
   Halteres black; mesonotal hair yellow . . . . . sp. inc.
   Halteres and mesonotal hair yellow; ♀ thorax often with yellowish ground-colour . . . . . 6.
4. Wing-membrane whitish in ♂; A.R. nearly 3 . . . . . *picipes*, Mg.
   Wings greyish; A.R. under 2 . . . . . 5.
5. ♂. Coxite with rather large basal lobe . . . . . *longitarsus*, Goet.
   ♂. Coxite with small subapical lobe . . . . . *atriclavus*, Kieff.
6. Hind L.R. only about 0·35 . . . . . *fuscipes*, Mg.
   Hind L.R. almost 0·5 . . . . . 7.
7. A.R. about 1·7; body of ♀ partly yellowish . . . . . *hirticollis*, Staeg.
   A.R. barely 1·0; body of ♀ all black . . . . . *martinii*, Thnm.
   A.R. about 0·5, last segment strongly clubbed . . . . . *gracei*, sp. n.

M. picipes, Mg. (*fuscipes*, Goet.; ? *paganicus*, Walk.; *hirtipalpis*, Kieff., 1915*b*; ? *hygropetricus*, Kieff., 1912*b*). All black, including halteres of ♂, though ♀ halteres may be brownish-yellow. Mesonotal hair black in both sexes. A.R. 2·5–3. Hypopygium with a small subapical lobe to coxite. Wings of ♂ with a rather distinct milky tinge in the membrane (though the hair is greyish); stem vein conspicuously black; wing-hair rather scanty on basal half in ♂, but dense in ♀. R_{4+5} shorter than in most of the related species. Rather common.

As Meigen describes *M. fuscipes* as having white halteres, Goetghebuer's identification of it with this species is evidently incorrect.

M. longitarsus, Goet. Similar to *M. picipes*, but A.R. under 2; wings not distinctly whitish and stem vein not conspicuously black; hypopygium with a rather large rounded lobe on basal half of coxite, and a small lobe at tip of style. Common.

M. atriclavus, Kieff. (?), 1921*d*. Antennae and wings as in *M. longitarsus*, but hypopygium almost as in *M. picipes*. Common.

M. sp. inc. Halteres black, but mesonotal hair yellow. R_{4+5} straight. Letchworth, Herts., 2 ♀ (antennae in one abnormal, 9–10 segmented). Bollin Valley, Cheshire, 1 ♀ (*Britten*).

M. fuscipes, Mg. (*adjunctus*, Walk.; *alligatus*, Walk.; *fertus*, Walk.; *obsistens*, Walk.; ? *deproperans*, Walk.; *auripilus*, Goet.). Body and legs usually all black in both sexes; halteres and mesonotal hair yellowish; occasionally

(as in Walker's type of *deproperans*) the ground-colour of the thorax may be brownish, especially in the ♀. Differs from most or all of the other species of the group in the shortness of the first segment of the hind tarsi, which is hardly more than one-third as long as the tibia. A.R. about 1; costa moderately produced; distance from tip of costa to tip of media equal to that from tip of *M* to tip of Cu_1. Abundant everywhere; I have reared it from green larvae found in moss growing on the ground in woods, and believe the larvae are normally terrestrial.

M. martinii, Tnm. (*cavicola*, Kieff., 1921*d*). Similar to *M. fuscipes*, but smaller; A.R. rather under 1; first segment of hind tarsus almost half as long as the tibia; costa more strongly produced, distance *C-M* less than M-Cu_1. Hypopygium almost as in *M. longitarsus*, but style less distinctly lobed at tip. Common; breeds in water in holes in beech and other trees; most of my adults have been derived from such sources and I have seldom if ever found them on the wing. The larvae are more often found in holes containing clear water than in those with dark brown tanninised water such as is preferred by Culicidae.

M. hirticollis, Staeg. (*hirtellus*, Goet.). ♂. Black with blackish legs, halteres usually yellowish, but sometimes more or less darkened; ♀ with scape of antennae, ground-colour of thorax, venter and legs yellowish. Mesonotal hair in both sexes yellow; venation, tarsi and hypopygium as in *M. martinii*, but A.R. about 1·7. Common.

M. atratulus, Zett. (? *lacteolus*, Goet.). ♂. Black, with yellowish or brown halteres and milky-white wings, the hair as well as the membrane being whitish; ♀ with ground-colour of thorax light to dark brownish, halteres yellow. A.R. about 1·2. Mesonotal hair black in ♂, yellowish in ♀. Costa rather strongly produced. Wing-length only about 2·5 mm. Common.

M. tristellus, sp. n. Entirely black in both sexes, including legs and halteres; integument scarcely shining, but without grey dusting; hair dark. A.R. about 1·2, plume rather scanty. Antennae of ♀ with segment 2 hardly longer than 3, 3–6 each with a pair of rather thick sense-bristles, broad at the base, 6 not much longer than 5. Palpi unusually short, segments 3 and 4 under three times as long as broad, 2 rather longer. Hypopygium (fig. 3*b*) with rather long and slender anal point; coxite and style not distinctly lobed. Legs stout, especially the femora; first segment of hind tarsus rather less than half as long as the tibia; empodium hardly distinguishable. Wings (Plate XVII, fig. 10) greyish, very scantily haired; hairs in ♂ confined to outer third or less, except for a few in anal cell, these being more numerous towards anal angle; wings in ♀ rather more hairy, but still mainly bare on basal half. Costa strongly produced, distance *C-M* rather less than M-Cu_1; *fCu* a little beyond *r-m*; Cu_2 curved downwards but not bent; *An* reaching only a short distance beyond *fCu*; lobe rather obtuse. Wing-length 2 mm. Hauxton, Cambs., 27.iv.1916, 2 ♂ 1 ♀; Baldock, Herts., iii.1928 (*F.W.E.*).

In most respects this answers to the description of *Gripekovenia tristis*, Kieff. (Asia Minor), but the plume of the ♂ antenna appears to be better developed and the A.R. greater.

M. gracei, sp. n. ♂. Brownish; scutal stripes, etc., darker brown. A.R. only 0·5, last segment rather strongly clubbed and with longish pubescence at tip. Palpi with the last segment much the longest. Hypopygium (fig. 3*c*) with long, bare anal point; styles very long; no distinct basal lobe. Legs brownish; front L.R. about 0·6, hind L.R. 0·55; no tarsal spurs; empodium nearly as long as claws. Wings greyish, rather densely hairy except near

base; venation as in the other members of this group, except that *r-m* is shorter and less oblique, and *fCu* rather more distal to *r-m*. Halteres yellowish. Wing-length about 2·2 mm. Ilkley, Yorks. (*Grace*). In most respects this answers to Kieffer's description of *M. fulvofasciatus* (1921*d*), but in that species the last antennal segment is said to be only slightly clubbed, and the median scutal stripe divided.

Group B.

(*Thienemannia*, Kieff., 1909.)

Eyes pubescent. Antennae of ♂ with only 12–13 segments. Legs slender; front L.R. about 0·65, hind L.R. about 0·55 ; tarsal spurs just distinguishable. Wings not very densely hairy; costa strongly produced; R_{4+5} ending just beyond level of tip of Cu_1; $R_2{}^{+}{}_3$ running close to R_1; *r-m* more nearly transverse than in Group A; Cu_2 gently curved; *fCu* scarcely beyond *r-m*. Squama almost bare (2 small hairs only in the British species). Stem vein with two hairs.

M. gracilis, Kieff. (?). A very small delicate species; wing-length under 2 mm. Thorax yellowish; scutal stripes dark brown; abdomen brown. A.R. only 0·25–0·3. Common about small waterfalls and rapids. Arran; Westmorland; N. Wales; S. Devon (*F.W.E.*).

Our specimens have 13 segments in the ♂ antennae, instead of 12 as stated by Kieffer, who, moreover, does not mention the size of his specimens.

Group C.

(*Heterotrissocladius*, Spärck., 1922.)

Hind tarsi without spurs. Front L.R. about 0·85–0·9, hind L.R. about 0·65. Femora moderately slender. Costa ending abruptly at R_{4+5}, which reaches beyond level of tip of Cu_1. R_{2+3} ending well beyond R_1; R_1 nearly two-thirds as long as R_{4+5}; *r-m* very oblique; Cu_2 bent forward at tip only; *An* reaching far beyond *fCu*. Stem vein hairy. Squama with complete fringe. Hypopygium with short, hairy anal point.

This includes but two British species, which are very distinct from the rest in structural characters, and in venation at least, are intermediate between *Metriocnemus* and *Brillia*. The generic name *Heterotrissocladius* was founded on larvae and pupae of *Metriocnemus longicollis*, Kieff., *M. cubitalis*, Kieff., and *M. triangulifer*, Kieff.

M. marcidus, Walk. (*aestivalis*, Goet.; ? *cubitalis*, Kieff., 1911*b*; ? *triangulifer* Kieff., 1924*c*). A rather large species (wing-length 3·5–4 mm.); scutal stripes usually separate, sometimes fused in ♂; halteres yellow. Wings hairy all over; membrane scarcely coloured; stem vein with several hairs. Common.

M. grimshawi, sp. n. Structural characters (venation, antenna, legs) as in *M. marcidus*, but differs as follows :—Wings (Plate XVII, fig. 8) hairy at the tip only, few hairs at tip of cell Cu_1 and very few or none in anal cell; membrane distinctly tinged with brown when viewed by transmitted light. Stem-vein with one or two hairs only. Hypopygium very much as in *M. marcidus*, but anal point scarcely differentiated (though the ninth tergite is sharply pointed in the middle), lobe of coxite less rounded, and subapical expansion of style more distinct. Wing-length 2·5 mm. Glencorse, 8.ix.1898, 1 ♂ (*Grimshaw*). Killarney, vi.1929, 1 ♂ (*F.W.E.*). In the latter specimen the thorax is mainly shining black, scutal stripes completely fused.

Group D.

(*Paraphaenocladius*, Tnm., 1926.)

Hind tarsi without minute spurs. Front L.R. about 0·75, hind L.R. about 0·65. Femora slender. Empodium fairly long. Costa more or less produced, but R_{4+5} ending well before level of tip of Cu_1. R_{2+3} ending well beyond R_1, or else R_1 and R_{4+5} are very close together; R_1 at most half as long as R_{4+5}; *r-m* nearly transverse; Cu_2 more or less bent in middle. Stem vein bare or with a single hair only. Squama more or less fringed. Hypopygium with broad, hairy anal point.

This includes four or five British species, all of which are small, with a maximum wing-length of 2·5 mm. Kieffer's *M. ampullaceus* (1923*c*), on which

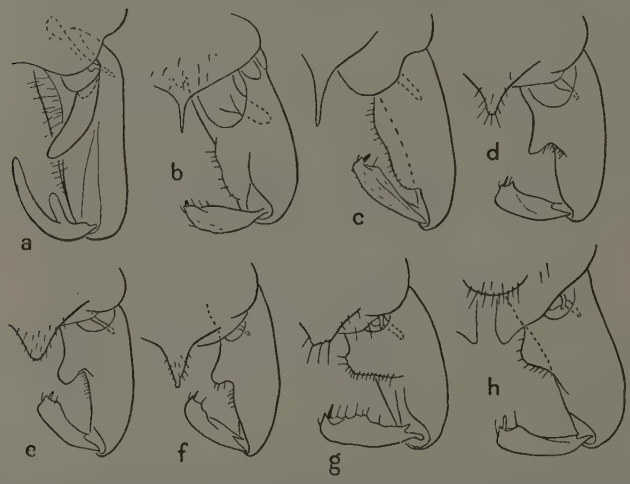

Fig. 3.—♂. Hypopygium (right half, from above) of species of *Brillia* and *Metriocnemus*. a, *B. longifurca*, Kieff. b, *M. tristellus*, sp. n. c, *M. gracei*, sp. n. d, *M. irritus*, Walk. e, *M. irritus*, Walk., var. f, *M. penerasus*, sp. n. g, *M. brumalis*, sp. n. h, *M. subnudus*, sp. n.

Thienemann founded his genus *Paraphaenocladius*, appears from the description to belong to this group, and may perhaps be identical with *M. impensus*. A female determined by Thienemann as *M. ampullaceus* and submitted to me for examination by Dr. Goetghebuer appeared to be a typical *M. impensus*.

M. impensus, Walk. (*angulatus*, Goet.). The largest of this group; wing-length 2–2·5 mm. Differs from the other four in having the costa only slightly (sometimes indistinctly) produced beyond R_{4+5}; distance *C-M* quite one-and-a-half times M-Cu_1; R_1 nearly half as long as R_{4+5}. Male typically blackish, with dark legs and fused scutal stripes, but often resembling the female in having pale legs and separate scutal stripes; the paler form is rather smaller and probably represents the summer broods, though closer study may possibly show that the two species have been confused. A.R. about 0·9–1·1. Hypopygium with broad, hairy anal point; basal lobe large and rather rounded. Wings rather densely hairy in both sexes; anal area obtusely rounded but fairly well developed; squama with complete fringe of short hairs. Abundant.

M. irritus (Walk.). Similar to *M. impensus*, but wings of ♂ much less densely hairy, basal half nearly bare; costa distinctly produced; distance *C-M* at most one and a third times *M-Cu*$_1$; R_1 less than half as long as R_{4+5}; hypopygium (fig. 3*d*) rather different, the anal point being shorter, style rather broader and basal lobe less rounded. Scutal stripes fused in the three males examined. Bricket Wood, Herts. (*F.W.E.*); Ilkley, Yorks. (*Grace*).

Variety? R_{4+5} shorter; costa more produced; A.R. only about 0·7. Hypopygium with anal point extremely broad, basal lobe very prominent (fig. 3*e*). Wicken, Cambs. (*F.W.E.*).

M. penerasus, sp. n. Wings (Plate XVII, fig. 11) almost as hairy as in *M. impensus*, but venation more as in *M. irritus*, the costa being still more strongly produced and R_1 much less than half as long as R_{4+5}. A.R. only about 0·4–0·6, last segment rather strongly clubbed. Squamal fringe reduced to 2–5 hairs. Hypopygium (fig. 3*f*) almost as in *M. impensus*. Scutal stripes well separated. Arran (*F.W.E.*); Newtown, N. Wales (*Miss Ricardo*); Rostherne, Cheshire (*Britten*).

M. cuneatus, sp. n. Head yellowish in front, dark above, as in related species; antennae similar to those of *M. impensus*, but last segment more extensively pubescent and with a long apical hair, which seems to be absent in *M. impensus* and *M. irritus*. Thorax with yellowish ground-colour, strongly pruinose between the scutal stripes, which are dark brown; scutellum pale. Abdomen blackish, darker than in the other species. Legs dark. Wings (Plate XVII, fig. 12) densely hairy, hairs relatively long and thick; costa strongly produced; R_{4+5} relatively short; anal area obsolete, hind margin running practically straight from alula; squama with a few hairs. Wing-length only 1–1·2 mm. Epping Forest (Wake Valley Pond), viii.1919, 1 ♀ and 24.vi.1929, 1 ♀ (*F.W.E.*).

Group E.

Legs as in Group C. *Eyes of ♂ with long, narrow dorsal projections.* Antennae of ♀ with verticil on last segment (absent in the other species). Costa produced; R_{4+5} ending above or scarcely before tip of Cu_1; R_{2+3} ending far beyond R_1, which is about half as long as R_{4+5}. Cu_2 with a strong double bend beyond middle. Stem-vein with a single hair. Squama with incomplete fringe. Hypopygium with long anal point.

Only one British species is referred here.

M. stylatus, Kieff., 1924*c* (*arciger*, Kieff., 1925*f*). Light brownish; scutal stripes, postnotum and sternum dark brown to black in ♂, reddish in ♀. Eyes of ♂ with long dorsal projection; those of ♀ strongly arcuate, but the dorsal part shorter and broader than in the ♂. A.R. about 1 (slightly more or less); antennae of ♂ with 3–4 very long curved hairs near tip, in addition to a bunch of shorter, straight hairs at extreme tip; long curved hairs sometimes present in ♀ about middle of last segment; segments 3–5 of ♀ antennae with rather long necks. Wing-length about 2·5 mm.; body 1·8 mm.(♀)–2·5 mm.(♂). (Kieffer says 1·5–1·8 mm.). Dovedale and Llangollen (*Verrall*); Newtown, N. Wales (*Miss Ricardo*); Ilkley, Yorks. (*Grace*); Hitchin and Letchworth, Herts. (*F.W.E.*).

Group F.

Eyes normal, reniform. Wings hairy at tip only, at least in ♂. Costa strongly produced; R_{4+5} ending near level of tip of Cu_1; Cu_2 strongly bent in middle; *fCu* well beyond *r-m*. Stem-vein with a single hair or none; squama quite bare. Front L.R.

variable; hind L.R. about 0·6; tarsi apparently without spurs. Empodium long. Hypopygium without anal point.

Three British species are referred here; in addition Kieffer's *M. mahensis* (Seychelles Is.) seems to belong to this group. The British species have not been reared, but from their occurrence in dry places in woods it would seem likely that their larvae are terrestrial.

M. subnudus, sp. n. ♂. Head dark brown above, face and palpi yellow, palpi of normal length. A.R. about 1·3; tip of antenna with moderately long pubescence. Thorax yellow, scutal stripes and postnotum dark brown. Abdomen brownish; hypopygium (fig. 3*h*) pale; no anal point; style long, rather narrow, with long terminal spine, before which on inner side is one rather strong bristle; coxite with rounded sub-basal lobe. Legs yellowish; L.R. about 0·7. Wings (Plate XVII, fig. 9) whitish; hairs almost confined to outer third, except for a few in anal cell. Costa very long, produced more than half-way from tip of R_{4+5} to tip of M. R_{2+3} running rather close to R_1 as far as tip of latter, then gradually fused with costa. R_1 about half as long as R_{4+5}. *Cu* usually almost completely bare (both stem and branches), Cu_1 sometimes bearing hairs; *fCu* much beyond *r-m*; fork narrow at base. *An* reaching only slightly beyond *fCu*. Lobe very obtuse. Halteres pale yellow.

♀. Almost all yellow, scutal stripes not much darker. Antennae long; segments 3–5 with rather long necks and long sense-bristles; 6 without sense-bristles or long curved hairs, but with longish pubescence on apical half. L.R. about 0·6. Wings much more hairy than in ♂, outer half fairly densely so, *Cu* hairy except at base. Venation as in ♂. Wing-length 1·5–2 mm.

Three Bridges, Sussex (*Verrall*); Brodick, Arran; Grange, Lancs.; Knebworth, Herts. (*F.W.E.*); Logie, Elgin (*Jenkinson*).

M. brumalis, sp. n. ♂. Blackish; palpi and legs dark brown, and even the halteres darkened. A.R. about 1·3, but tip of antenna with shorter pubescence than in the last species. Hypopygium (fig. 3*g*) without anal point, though the ninth tergite has several bristles on its margin. Styles considerably broadened in middle, with four or five stiff bristles on inner side. Basal lobe larger and more bristly than in the last species. L.R. about 0·6. Wings with a rather variable amount of hair; type agrees with last species in having hair almost confined to outer third of wing, and *Cu* bare, but another ♂ has quite outer half of wing and branches of *Cu* hairy. Venation as in the last species, except that R_{2+3} is further from R_1 and ends about midway between R_1 and R_{4+5}; costa perhaps not quite so long. Wing-length 1·6 mm.

♀. Head blackish above and on face. Last antennal segment half as long again as fifth, with short pubescence apically, and one rather longer terminal hair; 3–5 not quite twice as long as their breadth in the middle, narrowed apically. Thorax with yellow ground-colour, scutal stripes and postnotum blackish brown. Abdomen light brownish, except last segment; cerci not very dark. L.R. about 0·6, as in ♂. Wings more hairy than in ♂, but not densely clothed; hardly more than a single row of hairs in cell R_5. Halteres yellow. Baldock, Herts., ix–x.1917, 2 ♂ (*F.W.E.*); Crowborough, Sussex, 1 ♂ (*Jenkinson*). Welwyn, Herts, 24.xii.1927, 2 ♂, 22.ii.1928, 3 ♀ and 5.xi.1929, numerous ♀ (*F.W.E.*).

M. brevitarsis, sp. n. ♀. Brown; scutal stripes and sternum black; antennae and legs dark brown; halteres yellowish. Segments 3–5 of antennae oval, without distinct necks; verticils moderately long, sense-bristles slender and rather short; segment 6 not longer nor thicker than 5, with rather short

pubescence at tip only. Front L.R. only about 0·35, hind L.R. about 0·5. Fourth and fifth tarsal segments subequal in length. Empodia almost as long as claws. Wings rather scantily hairy on outer half and in anal cell. Costa rather less produced than in the last two species, but distance *C-M* less than *M-Cu*$_1$. R_{2+3} ending at about one-third the distance between R_1 and R_{4+5}. Cu_2 only slightly bent in middle; *fCu* well beyond *r-m*. *An* reaching slightly beyond *fCu*. Lobe obtuse. Wing-length 1·5 mm. Knebworth, Herts., iv.1922, 1 ♀ (*F.W.E.*).

This differs conspicuously from the last two in antennae and venation and the remarkably short front tarsi, the L.R. being less than in any other Chironomid known to me.

Cardiocladius, Kieff.

(*Spolia zeylanica*, 8, p. 22, 1912; Edw., 1924*c*.)

Eyes bare. Palpi with four distinct segments as in allied genera. Pronotum collar-like, just divided in middle. Ninth tergite of ♀ abdomen with a finger-like projection on each side. Fourth tarsal segment of posterior legs rather distinctly cordiform and much shorter than fifth. Empodia small; no pulvilli. Tibial spurs and comb normal. Wings (Plate XVII, fig. 13) bare, without macrotrichia or microtrichia. Lobe well developed. R_{2+3} ending well beyond R_1, but faint and not distinctly reaching costa. Base of cubital fork very little beyond *r-m*; Cu_2 almost straight and definitely reaching the margin without a forward curve at the extreme tip. *Ax* present and fairly distinct, lying between the two anal folds. Squama with complete fringe.

Differs from *Spaniotoma* mainly in the shape of the fourth tarsal segment, presence of vein *Ax*, and in the structure of the tip of the ♀ abdomen; also in characters of the early stages, which are passed in rivers and rapid streams. Two British species are known.

C. fuscus, Kieff., 1924*c*. Black; scutum shining; shoulders and pleurae heavily dusted with silvery-grey; pronotum, shoulders, and first two abdominal tergites black in ♂, yellow in ♀. Denham, Bucks. (*F.W.E.*); Kings Somborne, Hants. (*Audcent*). The species is doubtfully distinct from *C. ceylanicus*, Kieff. (genotype, Ceylon) and *C. nitidus*, Kieff. (Java).

C. capucinus (Zett.). Black, scutum not at all shining; shoulders and pleurae silvery grey, also (when seen from in front) the spaces between the scutal stripes as far back as the scutellum; seen from behind the black and grey areas are reversed. Dorsum of abdomen all black in both sexes. Fourth tarsal segment longer and less distinctly cordiform than in *C. fuscus*, but shorter than the fifth. Whernside; Teesdale; S. Devon (*F.W.E.*).

Cricotopus, v.d.W.

(Including *Trichocladius*, Kieff., part; *Isocladius* Kieff., 1909.)

Eyes densely pubescent. Scutum distinctly shining, humeral pits very small. Dorsocentral hairs minute and decumbent, the punctures from which they arise scarcely visible under a magnification of 100. Abdomen usually with yellowish markings. Styles (usually also coxites) of ♂ and cerci of ♀ usually white or whitish. Hypopygium without anal point. Tibiae usually with at least some indication of pale rings in middle. Small pulvilli present or absent. Wings more or less whitish, microtrichia absent or scarcely distinguishable even under a high power; lobe rather well developed, slightly prominent or right-angled. Costa rarely produced distinctly beyond R_{4+5}; R_{2+3} ending near or before half-way between R_1 and R_{4+5}. Squama with complete fringe.

The main feature on which van der Wulp founded this genus was the presence of white rings on the tibiae. This was regarded by Kieffer as insufficient to distinguish the genus, and he proposed instead to include in it all species (of the *Orthocladius* group) possessing hairy eyes and small pulvilli, irrespective of the colour of the legs, placing in his new genus *Trichocladius* both ringed-legged and dark-legged species which have hairy eyes but no pulvilli. I believe the presence or absence of pulvilli to be of small importance, and though the colour of the legs provides a convenient means of separating most of the species from *Orthocladius*, it is desirable if possible to supplement this by some distinction in structure. I believe that I have found such a character in the extreme reduction of the dorsocentral hairs of the scutum. In all the ringed-legged species these hairs are very minute and decumbent, whereas in all other genera of the subfamily they are much longer, suberect, and arise from large punctures which are easily discernible under a binocular microscope or even under a good lens.*

A few species, referred by Kieffer to *Trichocladius*, have no trace of white tibial rings, and have the genitalia in both sexes dark, but agree with typical *Cricotopus* in the vestigial dorsocentral hairs; I therefore include these species in the present genus. Support is gained for this procedure by the fact that Potthast from a study of larval and pupal characters places a *Cricotopus* such as *bicinctus*, Mg. (*atrimanus*, Kieff.), in the same group of *Trichocladius* as the dark-legged, marine *T. vitripennis*, Mg. (*halophilus*, Kieff.). These species also resemble *Cricotopus* in the structure of the hypopygium.

Through the kindness of Prof. Thienemann and Dr. Goetghebuer, I have examined a male specimen (probably the type) of *Isocladius albipes*, Kieff.; this appears to me to be nothing but an immature specimen of *Cricotopus sylvestris*, F., in which the colour characters are undeveloped and the last segment of both palpi is broken off.

We have at least 25 British species, which may be arranged in three groups :—

1. White tibial rings more or less distinct, at least on posterior legs; cerci of ♀ and usually hypopygium of ♂ white or whitish . . . . . 2.
   Tibiae unicolorous; genitalia light brown to blackish . . . . . *Group C.*
2. Small pulvilli present; wings milky . . . . . *Group A.*
   No pulvilli; wings not distinctly milky . . . . . *Group B.*

Group A.

Wings distinctly milky-white. Small pulvilli present. Front tarsi entirely dark in the ♂, often with slight beard. Hind tarsi often pale in middle. Tibial rings distinct (except in varieties of *C. sylvestris*).

In this group five British species are fairly well distinguished, but one of these is very variable in colour; possibly some of the forms regarded here as varieties are really distinct species. *C. brevipalpis*, Kieff., also belongs to this group and may be expected to occur in Britain; it differs from the other species in its shorter palpi.

1. Segments 1, 4 and 7 of abdomen mainly or entirely yellow . . . . . 2.
   Segments 4 and 7 largely dark . . . . . 3.

* The only species I have observed about which any doubt might arise on this point is *S.* (*Orthocladius*) *rubicundus*, Mg., in which the scutal punctures are very small.

2. Paler; middle scutal stripe abbreviated, the prescutellar area yellow *trifasciatus*, Panz.
   Darker; middle scutal stripe continued back to scutellum (♂♀) *tricinctus*, Mg.
3. Hind tarsi whitish except at base and tip; femora usually yellow on basal half or more . . . . . 4.
   Hind tarsi uniformly brownish, or only indistinctly pale in the middle; femora mainly blackish . . . . . 6.
4. Front tarsi of ♂ with distinct beard . . . . . *pilitarsis*, Zett
   Tarsal beard very short or absent . . . . . 5.
5. Scutellum blackish . . . . . *sylvestris*, Fabr.
   Scutellum yellow . . . . . *sylvestris* var. *ornatus*, Mg.
6. Front tibial ring distinct and pure white . . . . . 7.
   Front tibial ring indistinct or even absent; front tarsus of ♂ with slight beard . . . . . *sylvestris* var. *fuscimanus*, Mg.
7. Tibial rings all very narrow . . . . . *speciosus*, Goet.
   Tibial rings not unusually narrow. . . . . *sylvestris* var.

C. trifasciatus (Panz.) (? *pulchellus*, Mg.). Easily distinguished from all species of the genus except *C. tricinctus* by the three yellow bands of the abdomen, occupying segments 1, 4 and 7. Ground-colour of thorax clear yellow. Femora yellow with black tips. White bands of tibiae very broad. Bases of abdominal segments 2, 3 and 5 narrowly yellow. Common.

C. tricinctus (Mg.) (*hyalinus*, Kieff.). Differs from the last in having the middle scutal stripe continued back to the scutellum, the three stripes almost contiguous; femora mainly black; white tibial rings narrower; tergites 2, 3 and 5 of abdomen entirely black. Studland, Dorset (*Yerbury*); Hitchin, Herts., and Mildenhall, Suffolk (*F.W.E.*); Attenborough, Notts. (*Carr*).

C. pilitarsis (Zett.). Intermediate in colour between *C. trifasciatus* and *C. sylvestris*; segment 1 of abdomen all yellow, 4, 5 and 7 with rather narrow basal yellow bands; scutal stripes well separated. Differs from all the other species in having the ♂ front tarsi very distinctly bearded. Slapton, S. Devon (*Verrall, F.W.E.*).

C. sylvestris (Fabr.) (? *oscillator*, Mg.; *ornatus*, Mg.; ? *fuscimanus*, Mg.; ? *amoenus*, Mg.; ? *amasia*, Mg.; *marginatus*, Mcq.; ? *obscurimanus*, Zett.; *longipalpis*, Kieff.; *fusciforceps*, Kieff., 1921*c*). This appears to me to be a very variable species; the extreme forms look very different, but all gradations can be found between them, and there does not appear to be any structural difference. The form which I regard as typical has the scutal stripes well separated, but the scutellum blackish; abdomen with segment 1 mainly yellow, though with a dark mark above, 4 and 5 more or less extensively yellow at base, and 7 at apex, hypopygium entirely white; tibial rings distinct, that on front tibia pure white and very broad, femora all yellowish with black tips; hind tarsi mainly white except at tip. The var. *ornatus*, Mg., is similar, but has the scutellum yellowish. Darker specimens are frequently found in which the scutal stripes of the ♂ are broader, ground-colour of scutum brownish; yellow colour on abdomen reduced, especially on first segment; hypopygium more or less darkened at base; femora gradually darkened from base to tip; front tibial ring narrower, less clearly defined and brownish tinged; hind tarsi brownish. In the darkest specimens (which may perhaps be called var. *fuscimanus*, Mg.) the front tibial ring is scarcely distinguishable, and the hypopygium mainly dark. Perhaps *C. obscurimanus*, Zett., which has the scutal stripes quite fused, is a still darker form. Most of the specimens examined show a very slight beard on the front tarsi, much less distinct than in *C. pilitarsis*.

This species has more than once been reported to me as causing severe damage to water-lily leaves.

C. speciosus, Goet. One of the largest species of the genus, and rather more stoutly built than the others; readily distinguished from most by the narrowness of the white tibial rings, which occupy scarcely one-third of the length of the tibia. Scutal stripes separate; segment 1 of abdomen yellow, 4 and 7 largely but not entirely so. Front tarsi without beard. Hind tarsi dark. Cambridge (*Sharp*); Minchinhampton, Glos. (*Miss Ricardo*).

Group B.

Wings not distinctly milky. No pulvilli. Femora usually mainly black, also hind tarsi. White rings of tibiae usually distinct. Antennae of ♀ 6-segmented. R_{2+3} ending about midway between R_1 and R_{4+5}.

This includes about 14 British species, most of which are rather easily distinguished by colour characters.

1. Front tarsi with a white ring . . . . . 2.
   Front tarsi entirely dark . . . . . 3.
2. White tarsal ring involving third segment . . . . . *tremulus*, L.
   White tarsal ring confined to second segment . . . . . *pulchripes*, Verr.
3. Front tibial ring pure white . . . . . 4.
   Front tibial ring yellowish, often indistinct or even absent (cf. Group C).
4. Segment 4 of abdomen all yellow or leaden-yellow . . . . . 5.
   Segment 4 partly black . . . . . 10.
5. Segments 1 and 2 entirely yellow . . . . . *albiforceps*, Kieff., ♂.
   Segment 2 mainly dark . . . . . 6.
6. Segment 5 entirely yellow . . . . . *triannulatus*, Mcq., ♀.
   Segment 5 black, except narrowly on hind margin . . . . . 7.
7. Costa distinctly produced; scutal stripes separate (♂♀); hypopygium without basal lobe . . . . . 8.
   Costa less distinctly produced; scutal stripes fused, at-least in ♂; hypopygium with basal lobe . . . . . 9.
8. Front tibia broadly black at tip; *An* continued distinctly far beyond *fCu* *trifascia*, sp. n.
   Front tibia narrowly black at tip; *An* faint apically . . . . *similis*, Goet.
9. Front tibia only narrowly black at base . . . . . *bicinctus*, Mg.
   Front tibia as broadly black at base as at tip . . . . . *dizonias*, Mg.
10. Segment 4 of abdomen broadly yellow apically, black basally . *festivus*, Mg.
    Segment 4 yellow basally, or all black . . . . . 11.
11. Basal half or more of 4 and 5 yellow . . . . . *triannulatus*, Mcq., ♂.
    Segments 4 and 5 mainly or all black . . . . . 12.
12. Scutum entirely black . . . . . *tibialis*, Mg.
    At least the shoulders yellow . . . . . 13.
13. Tergites 2–8 of abdomen all black (♂♀) . . . . . *flavocinctus*, Kieff.
    Tergites 2–5 with yellow markings . . . . . 14.
14. Segment 2 of abdomen entirely clear yellow . . . . *albiforceps*, Kieff., ♀.
    Segment 2 at least with dark marks at sides, ground-colour less clear yellow *motitator*, L.

C. tremulus (L.) (*pictimanus*, Kieff., 1911*b*). Front tarsi with a white ring which includes the whole of the second segment and all but about the last quarter of the third. Scutal stripes fused in both sexes. First two abdominal segments yellow. Common in hilly districts.

C. pulchripes, Verr. (*montivagus*, Goet., 1912). The white ring on the front tarsi is confined to the second segment, and even the tip of this segment is black. Scutal stripes separate in both sexes. Abdomen with narrow yellow bands at bases of segments 3–5, in addition to having 1 and 2 yellow. Locally common in hilly districts: Devon, N. Wales, Yorkshire, Scotland.

C. albiforceps (Kieff., 1916) (*bicinctellus*, Goet.; ? *unifasciatus*, Mcq.). A small species, readily distinguished from all others (in the ♂) by having segments 1, 2 and 4 of the abdomen entirely yellow, the rest black. Scutal stripes more or less separate. Females taken on several occasions in company with these males have the first two abdominal segments entirely yellow, but the fourth tergite as well as tergites 3 and 5–7 entirely black. Though I have not observed them pairing, I have little doubt these are the females of this species. Rather common.

If I am not mistaken Goetghebuer has transposed his descriptions of the females of this species and *C. triannulatus*, which is rather curious as these two are the only species known to me in which the abdominal markings differ in the two sexes. Verrall had determined the present species with doubt as *C. unifasciatus*, Mcq.; Goetghebuer adopted this suggestion, but it should be noted that Macquart definitely stated that his specimens had the first abdominal segment and the *base* of the second yellow; this identification is therefore open to question.

C. dizonias (Mg.). Scutal stripes completely fused in ♂, shoulders usually more or less yellow, though in dark specimens the whole thorax is black; stripes in ♀ more or less separate. Abdomen black, segments 1 and 4 entirely leaden-yellow to leaden-grey, not clear yellow. Hypopygium (fig. 4*b*) white as usual; style with distinct triangular subapical lobe; coxite broader than in *C. bicinctus*, basal lobe longer and rather differently shaped. Legs mainly black, but all tibiae in both sexes with very distinct white rings, that on front tibia occupying about half the total length, black area at base being as long as or rather longer than that at tip. Wings as in *C. bicinctus* and related species; costa slightly produced. Wing-length about 2·5 mm. Ormesby, Norfolk (*Verrall*); Rostherne, Cheshire (*Britten*); Bonawe, Argyll (*Waterston*); Putney (*F.W.E.*).

I have adopted the name *dizonias* for this species because M. Séguy informs me that Meigen's type in the Paris museum (labelled by Meigen himself) has the front tibial ring placed *in* the middle, whereas in the type of *C. bicinctus* it is *before* the middle. Goetghebuer did not distinguish these two species.

C. bicinctus (Mg.) (? *gibbosus*, Mg.; *atrimanus*, Kieff., 1911*b*; *fallax*, Kieff., 1911*b*). Distinguished from all but the next two by the markings of the abdomen: segments 1 and 4 clear yellow in both sexes, 2–3 and 5–8 black. Scutal stripes completely fused in ♂, often more or less separate in ♀. Front tibia only narrowly black at base, more broadly so at tip. Femora blackish. Hypopygium (fig. 4*a*) with well-developed basal lobe to coxite, but styles without subapical lobe. Common.

According to Meigen's description of *C. bicinctus*, the abdomen has segments 1, 2 and 5 yellow; this is not the case in his type, and the description is doubtless erroneous. Specimens received from Thienemann as *atrimanus*, Kieff., and *fallax*, Kieff., are both identical with our *C. bicinctus* and do not show the tarsal difference mentioned in the diagnosis.

C. similis, Goet. Resembles *C. bicinctus* in colour of abdomen, but scutal stripes well separated in both sexes; costa distinctly produced; and ♂ coxite without trace of basal lobe, the function of the lobe being assumed, apparently;

by processes from the anal membrane. White ring occupying fully two-thirds of front tibia, the tip of which is only narrowly black, to about the same extent as at the base. Wings with anal lobe not at all produced; *An* ending almost opposite *fCu*, or continued only faintly beyond this point; no thickening of membrane in axillary region. Wing-length 1·8–2·2 mm. Ilkley (*Grace*); Skirwith, Cumberland (*Britten*); Sidmouth, S. Devon.; Holker Moss, Lancs., and Rydal, Westmorland (*F.W.E.*).

C. trifascia, sp. n. (Verrall MS.). Very similar to the last, differing as follows:—Size larger (wing-length about 3 mm.). Front tibia with the white ring occupying only about half the length, black area at tip quite twice as broad as that at base. Wings with anal lobe slightly produced; *An* continued

Fig. 4.—♂. Hypopygium (right half, from above) of species of *Cricotopus*. a, *C. bicinctus*, Mg. b, *C. dizonias*, Mg. c, *C. trifascia*, sp. n. d, *C. flavocinctus*, Kieff. e, *C. pallidipes*, sp. n. f, *C. biformis*, sp. n. g, *C. lacuum*, sp. n. h, *C. obnixus*, Walk. i, *C. inserpens*, Walk. j, *C. obtexens*, Walk.

far beyond *fCu*, its apical portion not becoming fainter; a broad thickening of membrane in axillary region representing vein *Ax*. Dovedale (*Verrall*); Glapton, Notts. (*Carr*); Sidmouth, S. Devon., and Temple Sowerby, Westmorland (*F.W.E.*).

This may be only a form of the preceding, especially as the hypopygium (fig. 4*c*) is identical in structure, but the differences mentioned appear to be constant. From the few characters mentioned by Goetghebuer for his *C. similis* it is impossible to be certain which of these forms he had before him; I have selected the first in order to preserve Verrall's name for the second. Presumably the three bands indicated by the name *trifascia* are those on the first and fourth abdominal segments and on the hypopygium.

C. festivus (Mg.) (? *laccophilus*, Kieff., 1916; *angustus*, Goet.). A small species with black femora and fused scutal stripes (♂♀); readily distinguished by having the fourth abdominal segment (♂♀) black on the basal half, yellow

on the apical half; there is also a narrow yellow band on the apex of the second segment. Meigen's description corresponds. The name *angustus* (a manuscript one bestowed by Verrall) was first published by Goetghebuer in his key to the Belgian species (1927); although he does not give a full description, the characters mentioned in his key are quite sufficient for the recognition of the species. Slapton, S. Devon (*Verrall*); Beesands, S. Devon; Wicken, Cambs.; Bramhope, Yorks. (*F.W.E.*); Forres, N.B. (*Jenkinson*).

C. triannulatus (Mcq.) (*suecicus*, Kieff., 1916; *triannulatus*, Goet.). Macquart's description, though brief, leaves no doubt as to the identity of his insect, the abdominal markings being distinctive. The ♀ differs from the ♂ in the absence of the black apical bands on abdominal tergites 4 and 5, which are entirely yellow. Goetghebuer associated this ♀ by mistake with his *C. bicinctellus*. Richmond, Surrey (*Gotch*); Ilkley, Yorks. (*Grace*); Fatfield, Durham (*Bagnall*); Bonawe, Argyll (*Waterston*); Oxford (*Hamm*); Rydal (*F.W.E.*).

C. motitator (L.) Mg. (? *annulipes*, Mg.; ? *lacustris*, Kieff., 1916; *annulator*, Goet., 1927*a*). Scutal stripes just separate or more or less fused in ♂, usually distinctly separate in ♀. Abdomen with segment 1 yellow, 2–5 also more or less yellow both basally and apically, the yellow usually more extensive at bases of 4 and 5; ♀ abdomen often more yellow than that of ♂. Very common.

Var. *annulator*, Goet. Dark colour of second abdominal segment reduced to a narrow ring or lateral spots; front tibia as usual with the black area at apex two or three times as broad as that at the base. Not so common as the type.

Var. *subcoeruleus*, nov. Light areas of abdomen bluish-green instead of yellow; dark colour of second abdominal segment reduced to lateral spots; front tibia with the dark area at tip not much wider than that at base; hypopygium as in the type. Dovedale (*Verrall*); Dartmouth and Sidmouth (*F.W.E.*).

C. flavocinctus (Kieff. (?), 1924*c*). Scutal stripes completely fused in ♂ (though leaving shoulders yellow), almost or quite fused in ♀. Abdomen in both sexes with segment 1 yellow, remaining tergites all black; with narrow shining grey posterior margins; venter of ♀ yellow towards base. Hypopygium (fig. 4*d*). Femora black; front tibia with very broad white ring, the black at tip being hardly more extensive than that at base. Size very small; wing-length only 1·5–2 mm. Gormire, Yorks. and Epping Forest (*F.W.E.*).

Kieffer's description of the male style as four times as long as broad, with a small tooth before the tip, does not accord very well with our specimens, but a specimen with extended style would perhaps answer to the description.

C. tibialis (Mg.) Goet. Scutum (at least in ♂) entirely black; abdomen black with shining greyish bands; all tibiae with white rings, which are rather variable in width. Apparently uncommon: Reading (*Gotch*); Knebworth, Herts.; Gormire, Yorks (*F.W.E.*). All the British specimens examined are smaller than a Belgian ♂ sent me by Goetghebuer (wing-length about 2·5 instead of about 4 mm.). All have the wings greyish rather than white as described by Meigen; the identity of the specimens and the validity of the species are somewhat doubtful. Antennae of ♀ 6-segmented as usual, and fine hairs on prescutellar area not specially numerous.

C. intersectus (Staeg.) (*incisuratus*, Zett.). A small species, wing-length barely 2 mm. Almost entirely black; first segment of abdomen and posterior margins of following segments shining leaden-grey. Front legs entirely dark, but traces of pale rings on the posterior tibiae, and hypopygium mainly white, its structure almost as figured by Goetghebuer for *C. annulipes*. Mitcham, Surrey, and Beesands, S. Devon (*F.W.E.*).

I am indebted to Dr. W. Lundbeck for the loan of a cotype of this species from Staeger's collection, by comparison with which our specimens have been determined.

C. pallidipes, sp. n. Size of *C. intersectus*, but scutal stripes well separated; abdomen slightly and uniformly shining, brownish; front tibia with outer half pale (except tip), posterior tibiae and tarsi mainly pale; hypopygium (fig. 4*e*) differs. Palpi normal, slender and 4-segmented. Antennae of ♀ 6-segmented as in *C. intersectus*. Newtown, N. Wales, and Brockenhurst, Hants. (*Miss Ricardo*); Bonawe, Argyll (*Waterston*).

Group C.

Tibiae either unicolorous, or only indistinctly pale in middle, especially in ♀. No pulvilli. Hypopygium of ♂ mainly or all dark; cerci of ♀ yellowish brown or black, never pure white. Antennae of ♀ often distinctly 7-segmented (second segment divided). R_{2+3} often ending distinctly before midway between R_1 and R_{4+5}.

This includes an uncertain number of species, the limits between which are for the most part very poorly defined. The following attempt at a key is merely provisional; I have included two species which occupy an intermediate position between groups *B* and *C*, and have been dealt with under the former.

1. *An* either ending about opposite *fCu* or continued only faintly beyond this point . . . . . 2.
   An continued far beyond *fCu* and not becoming faint apically . . . . 4.
2. Wings strongly milky, about 2·3 mm. long . . . . . *obnixus*, Walk.
   Wings scarcely milky, about 1·8 mm. long . . . . . 3.
3. Tibiae and tarsi pale; abdomen slightly shining . . . . *pallidipes*, sp. n.
   Legs dark; abdomen with shining bands . . . . . *intersectus*, Staeg.
4. R_{2+3} ending only a little before midway between R_1 and R_{4+5} . . . . 5.
   R_{2+3} ending at about one-third of this distance. . . . . 9.
5. Abdomen with shining bands at joints . . . . . *biformis*, sp. n.
   Abdomen uniformly dull or slightly shining . . . . . 6.
6. Thorax shining black, scutal stripes quite fused in ♀; antennae of ♀ 6-segmented . . . . . 7.
   Thorax less shining, at least shoulders pale in ♂ and scutal stripes separate in ♀; antennae of ♀ 7-segmented . . . . . 8.
7. Halteres blackish; thorax of ♀ all black . . . . . *lygropis*, sp. n.
   Halteres yellow; shoulders of ♀ yellow . . . . . *lacuum*, sp. n.
8. Scutal stripes black in ♂ . . . . . *obtexens*, Walk.
   Scutal stripes brownish in ♂ . . . . . *inserpens*, Walk.
9. Antennae of ♂ normal, A.R. 1·1–1·6 . . . . . *vitripennis*, Mg.
   Antennae of ♂ short, A.R. 0·6–0·8 . . . . . *fucicola*, Edw.

C. lacuum, sp. n. ♂. Almost entirely shining black, even the scutellum moderately shining, abdomen uniformly so; pronotum, pleural membrane, a very small area on shoulders, all trochanters and halteres yellowish. A.R. about 1·3. Small hairs on area in front of scutellum rather more numerous than usual. Hypopygium (fig. 4*g*) entirely black, with large, simple basal lobe on coxite. Front tibia entirely blackish, posterior tibiae sometimes faintly paler in middle. Front tarsi without beard. Wings without milky tinge, conspicuously yellow at base, including squama and stem vein. Cross-vein not darkened. Costa not or scarcely produced. ♀. Resembles ♂, but shoulders more extensively yellow, and posterior tibiae with more obvious traces

of light brownish rings towards base. Antennae 6-segmented, last segment pointed, not quite as long as 3–5 together. Cerci yellow. Wing-length 3 mm. Windermere, vi.1929, 6 ♂, 3 ♀ (*F.W.E.*); Loch Fad, Bute, 1 ♀ (*Grimshaw*).

This resembles *C. humeralis*, Zett. (*ephippium*, Zett.), which has not yet been recorded from Britain but is likely to occur here; if I have determined Zetterstedt's species correctly, it differs from *C. lacuum* in its larger size and presence of a conspicuous beard on the front tarsi of the male. *C. lacuum* also greatly resembles and may be merely a variety of *C. lestralis*, Edw. (Spitsbergen); the latter differs chiefly in having the squama and wing-base dark.

C. lygropis, sp. n. ♀. Entirely black, including antennae, legs and halteres; only the cerci yellow, contrasting strongly with the black abdomen. Last (6th) antennal segment pointed, fully as long as 3–5 together, with numerous curved hairs which are slightly flattened towards their tips. Palpi long, fourth segment half as long again as third. Thorax brightly shining (scutellum dull as usual), no trace of yellow on shoulders. Hairs on pre-scutellar area very minute and few in number. Abdomen dull, without shining bands. Tibiae quite uniformly black, L.R. about 0·7. Wings with slight milky tinge, anterior veins and cross-vein dark. R_{2+3} ending a little before midway between R_1 and R_{4+5}. *An* continued distinctly to within a short distance of margin of wing. *Ax* absent. Wing-length 3·5 mm.

Rydal, Westmoreland, vi.1929, 1 ♀ (*F.W.E.*). This insect bears much resemblance to *Spaniotoma* (*Trichocladius*) *lucida*, but is readily distinguished by the absence of dorsocentral hairs on the scutum.

C. biformis, sp. n. (? *glauciventris*, Kieff., 1911*b*). Size rather large (wing usually over 3·5 mm.). Scutal stripes in ♂ more or less fused, rarely quite separate, in ♀ always separate. A.R. 1·8–2. Antennae of ♀ with 7 segments. Abdomen dull blackish, first segment and broadish bands over the joints between the other segments shining leaden-grey, sometimes green or yellowish in life, especially in ♀. Hypopygium (fig. 4*f*) mainly dark, but styles pale; basal lobe rather large and prominent, but strongly emarginate on inner margin; terminal spine of styles long. Cerci of ♀ yellowish. Legs mainly dark, front tibial ring fairly distinct in ♀, absent in ♂, but at least some trace of lighter rings on the other legs, more distinct in life. Common. Devon, Sussex, Gloucester, Herts. Beds., Yorks., Westmorland. Type from Radwell, Herts. (*F.W.E.*).

This is the species which was determined (wrongly) by Verrall as *C. ephippium*, Zett., and recorded by me (1920) as *Trichocladius ephippium*. It is of interest as having two forms of the male, one of which has the antennae constructed as in the female and the body similarly shaped. The name *biformis* has already been mentioned in print (Léger and Motas, 1928), and I therefore make use of it, although I have little doubt that the species is Kieffer's *glauciventris* (of which, however, only a brief and inadequate diagnosis has been published). As the species is common and widespread it is surprising that none of the earlier authors appear to have described it. Before examining Staeger's type I took it to be his *C. intersectus*, and it may have been so determined by others.

C. vitripennis (Mg.) (*variabilis*, Staeg.; ? *kervillei*, Kieff.). Thorax distinctly dusted with grey; scutal stripes blackish and usually contiguous in ♂, brown and separate in ♀, in which sex the middle stripe is often lighter than the lateral pair, especially anteriorly. A.R. 1·1–1·4; antennae of ♀ 7-segmented. Front tarsi of ♂ without beard. Hypopygium: basal lobe large and prominent; style with small rounded expansion on inner side before tip. Wings broad, especially in ♀; lobe in ♂ rather prominent. R_{2+3} ending about one-third of

the distance between R_1 and R_{4+5}. Wing-length about 3·5 mm. Rocky coasts of Scotland, and probably elsewhere; larvae in the sea.

Variety *halophilus* (Kieff., 1909). Similar to *C. vitripennis*, but smaller (wing-length about 2·5 mm.); scutal stripes separate in ♂, light brownish in ♀; whole thorax of ♀ often yellowish-brown. Hypopygium much as in *C. vitripennis*, perhaps a slight difference in shape of style and basal lobe. A.R. about 1·3. Numerous localities in England and Wales, mostly on or near estuaries, but also inland. A variety (?) from Arran is almost black; A.R. barely 1·2.

Material of *T. halophilus* received from Thienemann appears indistinguishable from our species. *T. brunnipes*, Goet., is very similar (acccording to the description), but is said to have 6-segmented antennae in the ♀.

C. fucicola (Edw., 1926). Blackish; scutal stripes more or less separate in ♀; halteres yellow as in the preceding; wing-length about 2 mm. Venation as in *C. vitripennis*. Antennae of ♂ unusually short and with rather scanty plumes; A.R. about 0·6–0·8, but penultimate segment hardly longer than broad. On rocky coasts: S. Wales, N. Devon, Isle of Arran. Larvae probably marine.

C. obtexens (Walk.). A rather large species; wing-length 3·5–4 mm. Scutal stripes almost fused in ♂, separate in ♀; in both sexes black and distinctly shining; ♀ abdomen blackish, cerci rather light brown. A.R. about 2. Antennae of ♀ 7-segmented, 2 short but constricted near middle, 4–6 shortly oval, longer than in *C. vitripennis*. Front tarsi of ♂ with slight beard. Hypopygium (fig. 4*f*) without anal point, constructed much as in *C. vitripennis*, but subapical expansion of style larger. R_{2+3} ending at about two-fifths of the distance between R_1 and R_{4+5}; *f Cu* below or scarcely beyond *r-m*, which is rather strongly darkened. Newmarket (*Verrall*); Oxford (*Hamm*); Sherwood Forest (*Carr*); Radwell, Herts. (*F.W.E.*). All the specimens were taken in March or April. A variety (?) from Dovedale, vi.1888 (*Verrall*) is rather smaller and lighter; tarsal beard not obvious.

Var. *inserpens* (Walk.). (*conversus*, Walk.; *denotatus*, Walk.). Smaller and much yellower than the last; scutal stripes well separated in ♂ and brownish in colour; *r-m* not darkened. A.R. about 1·7. Hypopygium (fig. 4*i*) hardly differs. Richmond, Surrey (*Gotch*); Quy, Cambs. (*F.W.E.*); Cambridge (*Jenkinson*).

C. obnixus (Walk.) (? *varians*, Staeg.; *nigriventris*, v.d.W.). Scutal stripes separate and shining black in both sexes, ground-colour of thorax yellowish-brown; abdomen in ♂ dull black, with narrow shining bands at bases of segments. A.R. about 1·4. Hypopygium (fig. 4*h*) with basal lobe much produced and thumb-like. Antennae of ♀ 7-segmented, but 2 and 3 not well separated, last segment hardly longer than 5 and 6 together, with longer pubescence than in *C. vitripennis* and related species; 4–6 oval. Cerci blackish. R_{2+3} ending at or scarcely before the middle point between R_1 and R_{4+5}. Wings much more distinctly milky than in the other species of this group. Halteres yellow, base of stem blackish. Arran (*F.W.E.*). One of Staeger's specimens is probably this species, but his series also included a *Psectrocladius*.

SPANIOTOMA, Phil.

(Including *Orthocladius*, *Camptocladius*, etc.)

The bare-winged genera of this subfamily are all, with the exception of *Corynoneura* and *Cardiocladius*, very closely related and show no important

structural differences. I have tried in vain to discover clearly marked distinctions between the recently proposed genera, and have come to the conclusion that it will be best to re-unite most of them under the oldest name *Spaniotoma*, admitting *Cricotopus* as distinct on the ground of the absence of erect dorsocentral hairs on the thorax. Some of the genera proposed by van der Wulp, Kieffer and others are admitted here as subgenera, but there are many species which are very difficult to place as they combine the typical characters of two or more of these subgenera.

The name *Spaniotoma* was introduced by Philippi (1865) for two Chilean species, the type being designated later as *S. bivittata*. The genus was not very fully described, but the description leaves little doubt that the insects belonged to the group under consideration.* The coloration described for *S. bivittata* ♀ is almost that of *Psectrocladius sordidellus*, Zett., and I suspect that if the type could be examined it would be found to belong to *Psectrocladius*. In this connection I may remark that I took a female midge in North-West Patagonia which evidently belongs to this subgenus and is either *P. sordidellus* or some closely related species; if Philippi's description and figure are not quite accurate (especially as regards the length of the last antennal segment), it may be *S. bivittata*.

The generic characters of *Spaniotoma* as here understood are the following:—

Eyes usually bare; in a few cases finely pubescent, and rarely densely and obviously pubescent as in *Cricotopus*. Palpi with four segments. Pronotum (with rare exceptions) forming a distinct but usually narrow collar reaching up to anterior edge of scutum. Single or double rows of suberect bristly hairs between scutal stripes and extending back to scutellum; the hairs always arising from distinct punctures which are visible (even in the smallest species) under a magnification of 50. Genitalia (♂♀) almost always dark. Legs slender; tibiae practically unicolorous, without any trace of white rings; hind tibia with comb on inner side at tip; fourth tarsal segment on all legs cylindrical, usually at least as long as fifth. Wings (except in one species) without macrotrichia even at tip; microtrichia usually absent, but when present very minute, visible only under a magnification of 300. Vein *Ax* absent or scarcely distinguishable.

Key to subgenera of *Spaniotoma*.

1. Wings colourless by transmitted light (membrane with distinguishable microtrichia, at least in ♀) . . . . . 2.
   Wings at least slightly tinted with brown or purplish by transmitted light (membrane bare) . . . . . 5.
2. *An* reaching well beyond *fCu*, lobe large and right-angled . . . . . 3.
   An ending opposite or just before *fCu*; lobe rounded; eyes bare . . . 4.
3. Eyes bare, squama fringed (if eyes pubescent and squama fringed, compare *Trichocladius*) . . . . . *Orthocladius*, Group A.
   Eyes pubescent, squama bare . . . . . *Diplocladius*.
4. Cu_2 straight, or only moderately bent beyond middle; *fCu* not much beyond *r-m* . . . . . *Orthocladius*, Group B.
   Cu_2 bent in middle; *fCu* well beyond *r-m* . . . . . *Limnophyes*
5. R_{2+3} at least slightly separated from R_{4+5} apically, usually ending in costa near or before midway between tips of R_1 and R_{4+5} 6
   R_{2+3} in contact with R_{4+5} throughout, not ending separately in costa *Eukiefferiella*.

* It is just possible that *S. bivittata* may be a *Cricotopus* of the *vitripennis* group. If that should be shown to be the case the present genus would have to be known as *Smittia*. The use of either of these names for the enlarged genus will, it seems to me, involve less confusion than the adoption of *Orthocladius*.

6. Squama with at least a few hairs; Cu_2 usually straight or only slightly curved; *fCu* rarely much beyond *r-m* . . . . . 7.
   Squama quite bare; Cu_2 usually more or less bent in middle; *fCu* usually well beyond *r-m* . . . . . *Smittia.*
7. Eyes pubescent . . . . . *Trichocladius.*
   Eyes bare . . . . . 8.
8. Pulvilli present, rather large and broad . . . . . *Psectrocladius.*
   Pulvilli absent, or if (rarely) present, then quite small or narrow *Orthocladius.*

Subgenus **Trichocladius,** Kieff.

(*Acricotopus*, Kieff.; ? *Paratrichocladius*, Sant.)

Eyes pubescent, but usually less densely so than in *Cricotopus*, the hairs shorter than the diameter of the facets. Scutum usually rather brightly shining; humeral pits often unusually large. Small pulvilli present or absent. Wings more or less whitish, without distinct microtrichia. R_{2+3} ending near middle point between R_1 and R_{4+5}. Cu_2 not or slightly bent; *fCu* not much beyond *r-m*. *An* reaching distinctly beyond *fCu*. Squama with complete fringe.

I propose to include in this subgenus a small number of species which are similar to *Orthocladius* in venation, and also in the possession of distinct, suberect dorsocentral hairs, but have very distinctly pubescent eyes; most of them also have the thorax more conspicuously shining than in any *Orthocladius*. Some of these species have been referred by Kieffer and Goetghebuer to *Trichocladius*, others to *Cricotopus*. Although the genotype (*T. fissicornis*, Kieff., from Concepcion, Chile) is insufficiently described, it is most probable that it belongs to one or other of the groups discussed below. It should, however, be noted that some species which I place in the subgenera *Eukiefferiella* and *Smittia* have pubescent eyes and have been referred by Kieffer to *Trichocladius*; also that most of the species described by Kieffer as *Trichocladius* belong to *Cricotopus*, in the sense in which that genus is here defined.

Acricotopus was founded by Kieffer for one species, *A. grandis*, Kieff., and was said to differ from *Cricotopus* in having very small pulvilli. In spite of some discrepancies, it seems very probable that in *A. grandis* Kieffer redescribed the species which he had previously called *Trichocladius sagittalis*, and I therefore regard this species as the genotype. Another generic name which may refer to this group is *Paratrichocladius*, Santos (1918); I do not know any of the ten species described.

The eight British species may be placed in two rather distinct groups.

Group A.

(*Acricotopus*, Kieff.)

Antennae of ♀ 7-segmented, last segment nearly or quite as long as the three preceding. Humeral pits of moderate size or small. Hypopygium without anal point. Pulvilli absent or very minute.

I am acquainted with only three British species; they are evidently related to *Cricotopus*, especially to Group C of that genus.

S. (T.) lucida (Staeg.) (*lucens*, Zett.; *coaequatus*, Walk.; *nitidicollis*, Walk.; *obsepiens*, Walk.; *patibilis*, Walk.; *pervulsus*, Walk.; ? *dilatatus*, v.d.W., *nec* Goet.; *sagittalis*, Kieff., 1908*a*; *funebris*, Goet., 1921*a*; ? *grandis*, Kieff., 1921*d*; ? *lobatus*, Kieff.). Body shining black in both sexes, shoulders some-

times indistinctly yellowish in ♀. A.R. about 3. Pronotum in both sexes unusually large. Humeral pits moderate. First few abdominal segments of ♂ with flat lateral expansions of the tergites. Front tarsus of ♂ with slight beard. Wings faintly milky; lobe in ♂ very strongly produced, hind margin emarginate beyond lobe; in ♀ right angled or very slightly produced. Forward bend of extreme tip of Cu_2 scarcely discernible. Halteres of ♂ dark. Size variable; wing-length 2–3·5 mm. Common.

S. (T.) rufiventris (Mg.) (? *perniger*, Zett., *opplens*, Walk.; ? *proximus*, Kieff.; *nudipes*, Goet.). Body shining black, shoulders and venter sometimes pale in ♀. A.R. 1·2–1·6. Pronotum not unusually large. Humeral pits moderate. Abdomen of ♂ without flat expansions of the basal tergites; more or less distinct shining bands at incisures. Front tarsus without beard. Wings without milky tinge, faintly purplish by transmitted light; lobe right-angled in ♂, rather obtuse in ♀. Halteres pale in both sexes. Average size much less than *S. lucida*; wing-length 2–2·8 mm. Common.

There is some variation in the ♂ styles and basal lobe, as well as in the antennae.

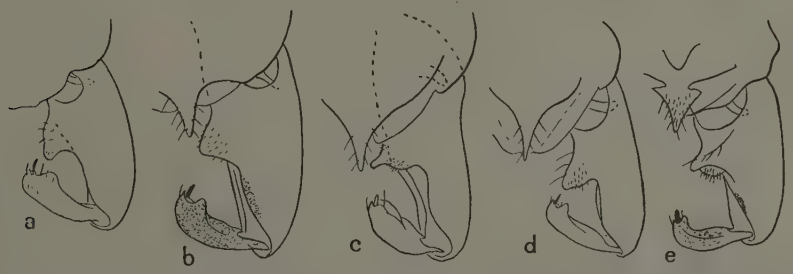

Fig. 5.—♂. Hypopygium (right half, from above) of species of *Spaniotoma*, subgenus *Trichocladius*. a, *S. skirwithensis*, sp. n. b, *S. glabricollis*, Mg. c, *S. effusa*, Walk. d, *S. foveata*, sp. n. e, *S. chalybeata*, sp. n.

S. (T.) skirwithensis, sp. n. ♂. Head black, including antennae and mouth-parts. A.R. slightly under 1. Thorax mainly black and slightly shining, but pronotum, shoulders and a large pleural patch yellowish, scutal stripes indistinctly separated in front. Humeral pits very small, scarcely distinguishable. Abdomen dull blackish, without definite shining bands at incisures. Hypopygium (fig. 5*a*) much resembling that of *S. rufiventris*. Legs blackish, except trochanters and extreme bases of femora. Wings as in *S. rufiventris*. Halteres yellow. Skirwith, Cumberland, 6.vii.1927, 3 ♂♂ (*Britten*).

This very much resembles *S. dispar*, except for the absence of pulvilli and the pale halteres.

Group B.

Antennae of ♀ 6-segmented, 6 usually rather short. Humeral pits usually large. Hypopygium with distinct hairy anal point. Pulvilli present.

Five British species, easily distinguished as follows:—

1. Humeral pits small . . . . . *dispar*, Goet.
   Humeral pits very large . . . . . 2.

2. Thorax dull . . . . . *effusa*, Walk.
   Thorax brightly shining . . . . . 3.
3. Halteres blackish, thorax sub-metallic . . . . . *chalybeata*, sp. n.
   Halteres yellow, thorax without metallic sheen . . . . . 4.
4. Wings milky; scutum black, stripes fused in ♀ . . . . . *glabricollis*, Mg.
   Wings not milky; shoulders yellow; stripes separate in ♀ . . *foveata*, sp. n.

S. (T.) dispar (Goet., 1913*a*, ? *fuscipes*, Kieff.). Differs from all the other species of the group in possessing small (normal) humeral pits. ♂. All blackish, including legs and halteres; scutum somewhat shining. A.R. about 1·5. R_{2+3} ending almost midway between R_1 and R_{4+5}; anal area somewhat obtusely rounded. ♀ taken *in coitû*. Ground-colour of thorax yellow, scutal strips well separated and slightly shining black; halteres light yellowish. Antennae 6-segmented, 2 not constricted, 6 hardly longer than 4 and 5 together. R_{2+3} ending at one-third the distance between R_1 and R_{4+5}. Common.

S. (T.) effusa (Walk.). ♂. Head blackish, including antennae and palpi. A.R. about 1·1, tip of antenna with rather long pubescence. Thorax dull black, grey lines between the scutal stripes, and grey dusting round the humeral pits, which are very large, elliptical, and longitudinally placed. Abdomen dark brown; style (fig. 5*c*) with long terminal spine and without conspicuous pre-apical expansion, much as in *S. dispar*; basal lobe squarish, with a projecting lobule at the corner. Legs dark brown; no tarsal beard; pulvilli distinct and over half as long as claws. Wings not milky, faintly purplish by transmitted light; costa slightly produced; R_{2+3} ending about midway between R_1 and R_{4+5}; lobe slightly obtuse. Halteres blackish.

♀. Coloration as in the ♂, except that the halteres are yellow. Antennae 6-segmented, 2 not constricted, 3–5 spindle-shaped, 6 nearly as long as 3–5 together and with long and rather dense pubescence. Costa more strongly produced than in ♂, and R_{2+3} ending at one-third of the distance between R_1 and R_{4+5}. Wing-length about 2·5 mm. Shropshire and Isle of Arran (*F.W.E.*).

S. (T.) glabricollis (Mg.). Head and thorax brightly shining black, shoulders and pleurae more or less yellowish in ♀; abdomen rather dull blackish brown; halteres yellow in both sexes. A.R. about 1·7. Antennae of ♀ 6-segmented, 2 somewhat constricted, 3–5 spindle-shaped, progressively shortened, with very long sense-bristles; 6 shorter than 4 and 5 together, with rather numerous and long curved hairs. Humeral pits in both sexes very large, almost round, light brownish. Scutellum with a large shining area at base. Hypopygium (fig. 5*b*). Legs blackish; no tarsal beard. Wings milky-white, with distinct brown tinge by transmitted light; costa, R_1 and R_{4+5} dark. Costa strongly produced, still more in ♀ than in ♂; R_{2+3} in both sexes ending about midway between R_1 and R_{4+5}; lobe right-angled. Snailbeach, Salop (*F.W.E.*).

S. (T.) foveata, sp. n. Structurally similar to the last, differing as follows :— A.R. 1·0–1·2. Segments 3–5 of ♀ antennae about equal in length. Shoulders and part of pleurae of ♂ yellowish, scutal stripes sometimes separate as in ♀; ♀ with ground-colour of scutum yellow, stripes shining black, middle stripe continued back to scutellum as a narrow blackish line. Hypopygium (fig. 5*d*). Wings (Plate XVII, fig. 16) faintly purplish by transmitted light, without milky tinge by reflected light, veins all dark; R_{2+3} in both sexes ending a little before midway between R_1 and R_{4+5}; lobe rather obtuse. Wing-length about 2·5 mm. Minchinhampton, Glos. (*Miss Ricardo*); Sidmouth, S. Devon; Corriegills, Arran (*F.W.E.*); Kincraig (*Grimshaw*). The specimens from Arran

differ in having the face of the ♂ and the first antennal segment of the ♀ blackish instead of yellowish-brown as they are in the others.

S. (T.) chalybeata, sp. n. Head and thorax shining black in both sexes, with a strong metallic blue sheen; scutellum wholly velvet black, without shining area at base; abdomen dull black, venter yellowish in ♀; legs and halteres blackish in both sexes. Humeral pits very large, round, and yellow in colour. A.R. about 1·3. Antennae of ♀ 6-segmented, 3–5 shortly oval, 6 almost as long as 3–5 together, but with long pubescence as in the other species of this group. Hypopygium (fig. 5*e*). Wings not milky, but with slight brown tinge by transmitted light. Costa not or scarcely produced. R_{2+3} in both sexes ending a little beyond midway between R_1 and R_{4+5}. Lobe right-angled in ♂, rather obtuse in ♀. Wing-length about 2·5 mm. Watford, Herts.; Biggleswade, Beds.; Shrewsbury, Salop; Sidmouth and Gorge of Dart, S. Devon; Staveley, Westmorland (*F.W.E.*); Ilkley, Yorks. (*Grace*).

It is surprising that this extremely distinct and apparently rather common species does not appear to have been described before, unless the North American *T. nitidus*, Mall., is the same; Malloch, however, does not mention the humeral pits, which in the British species are so conspicuous that they could not be overlooked.

Subgenus **Diplocladius,** Kieff., 1908*a*.

Eyes densely but very shortly pubescent. Scutum dull. Male hypopygium with styles double; basal lobe long and free. Tibial spurs better developed than usual, outer spur on hind tibia more than half as long as inner. Pulvilli absent. Wings greyish, with fine microtrichia but no macrotrichia; lobe rather large. Costa slightly produced; R_{2+3} ending about two-fifths of the way from R_1 to R_{4+5}; *fCu* not much beyond *r-m*; Cu_2 only gently curved; *An* continued far beyond *fCu*. Squama devoid of fringe.

S. (D.) cultriger, Kieff. (? *Trichocladius decipiens*, Kieff.). A blackish species, without ornamentation; very similar in appearance to *S.* (*Orthocladius*) *perennis*, Mg., from which it is readily separated by the pubescent eyes and bare squama. A.R. nearly 3; ♀ antennae 6-segmented, 3–5 rather elongate oval, almost cylindrical, with slender, simple sense-bristles. Probably common. Harrow, Middlesex; Letchworth and Knebworth, Herts. (*F.W.E.*). Most of the specimens were taken in winter or early spring.

According to Kieffer's original description the palpi have only three segments, but this is perhaps a mistake; all those I have examined have the normal four segments in the palpi. Kieffer seems to have redescribed the species as *Trichocladius decipiens*, recognising four segments in the palpi, but overlooking the pale, bare outer division of the style.

Subgenus **Psectrocladius,** Kieff.

(*? Spaniotoma*, Phil.)

Eyes bare. Pulvilli present, broad and distinct, usually very little shorter than the claws. Wings brown by transmitted light, without microtrichia. R_{2+3} ending at or before the middle point between R_1 and R_{4+5}. R_{4+5} reaching to or slightly beyond level of tip of Cu_1. Cu_2 not or scarcely bent; *fCu* hardly beyond *r-m*. *An* reaching far beyond *fCu*. Lobe usually very distinctly produced in ♂. Squama with a complete fringe.

This subgenus was introduced by Kieffer to include some medium-sized to large species, among which he designated *P. psilopterus*, Kieff., as the type.

Subsequently he added some other small species with short and narrow pulvilli, but recognised that these were not closely related to the others. We have two or three of these small species in Britain; in all of them R_{2+3} is approximated to R_{4+5} somewhat as in *Eukiefferiella*, but they are treated here as forming a group (F) of *Orthocladius*. The larger, typical species of *Psectrocladius* have more resemblance to typical *Orthocladius* (Group C), from which they differ only in the possession of pulvilli.

Goetghebuer and others have referred *Chironomus carbonarius*, Mg., and *Orthocladius dilatatus*, v.d.W., to this subgenus. Both these were described as shining black, and although the authors had both sexes before them no mention was made of a different colouring in the female. As no *Psectrocladius* is known to me with a shining black thorax in the female, I do not accept these determinations; I believe van der Wulp's description of *O. dilatatus* refers to *Trichocladius lucidus*, and possibly Meigen's *C. carbonarius* was also the same species; both types, however, are lost.

The character pointed out by Goetghebuer of the shape of the last tarsal segment is a very useful one for separating certain species, and there are also some useful characters to be found in the tibial spurs. The seven or eight British species may be recognised thus :—

1. Last segment of all tarsi flattened dorsoventrally (♂♀) . . . . . 2.
   Last segment of tarsi compressed laterally . . . . . 3.
2. Middle tibia with two distinct spurs . . . . . *obvia*, Walk.
   Middle tibia with outer spur very small or absent . . . . *platypus*, sp. n.
3. Outer spur of middle tibia short but distinct . . . . . *calcarata*, sp. n.
   Middle tibia with only one spur . . . . . 4.
4. Wing-length 2·5–4 mm.; lobe prominent in ♂; halteres pale . . . . . 5.
   Wing under 2 mm.; lobe rather obtuse; halteres blackish . *turfacea*, Kieff.
5. Wings only slightly milky; ♂ front tarsi with slight beard ? *sordidella*, Zett., var.
   Wings strongly milky; ♂ front tarsi with long beard . . . *barbimanus*, sp. n.
   Wings strongly milky; ♂ front tarsi without trace of beard . . . . . 6.
6. Colour lighter, scutellum of ♂ yellowish . . . . . 7.
   Darker, scutellum of ♂ blackish . . . . . 8.
7. A.R. about 2 . . . . . *sordidella*, Zett.
   A.R. about 1·3–1·6 . . . . . *stratiotis*, Kieff.
8. A.R. 2; R_{2+3} longer . . . . . ?*sordidella*, Zett., var.
   A.R. 1·5–1·7; R_{2+3} shorter . . . . . *limbatella*, Holmgr.

S. (P.) obvia (Walk.) (*oppertus*, Walk.; *extensus*, Kieff.; *carbonarius*, Goet. *nec* Mg.). The largest species of the genus; wing-length 3·5–5 mm. Last tarsal segment of all legs and in both sexes flattened, gradually increasing in breadth from base to tip; pulvilli very large. Middle tibiae with two very distinct spurs, outer not much shorter than inner; hind tibiae also with outer spur very distinct, more than half as long as inner. Shaft of ♂ antenna unusually thick and rather short; A.R. about 2; front tarsus bearded. ♂ Typically shining black, with yellow shoulders; ♀ with ground-colour of thorax yellow, scutal stripes separate and black, scutellum dark at base. Legs dark. Halteres yellow in both sexes (hence this cannot be v. d. Wulp's *dilatatus*). Mitcham, Surrey (*Miss Cheesman*); Manchester (*Britten*).

A variety (?) is rather smaller, has the scutal stripes distinctly separate in ♂, scutellum brownish in ♂, yellow in ♀. Porthcawl, Glamorgan (*Yerbury*); Wicken (*F.W.E.*); Arran (*F.W.E.*); Bonawe, Argyll (*Waterston*).

Another variety (?) has the scutal stripes and sternum in ♀ scarcely darker

than the yellow ground-colour, though the postnotum is black; all femora and four posterior tibiae yellowish. Aldeburgh, Suffolk (*Jenkinson*).

S. (P.) platypus, sp. n. ♂. Almost wholly black; a small area on shoulders and pleurae brownish, halteres dark brown. A.R. nearly 2; penultimate segment scarcely as long as broad; shaft of antenna not unusually stout. Scutum slightly shining, without distinct dusting. Hypopygium much as in related species; anal point rather well developed; basal lobe rather acute. Last tarsal segment flattened, as in *S. obvia*, but outer spur on both middle and hind tibiae absent or barely distinguishable. Pulvilli not quite so large as in *S. obvia*. Front tarsus without distinct beard. Wings (Plate XVII, fig. 14) with slight milky tinge, purplish by transmitted light; costa, R_1 and R_{4+5} dark, R_{2+3} reaching beyond one-third of the distance between R_1 and R_{4+5}; costa rather strongly produced; *r-m* rather long and very oblique; *fCu* a short distance beyond *r-m*; lobe rather strongly produced. ♀. Black, but ground-colour of scutum and pleurae brownish-yellow, and halteres yellow. Antennae 6-segmented; 2 somewhat constricted in middle; 3–5 shortly oval; 6 pointed, not or scarcely longer than 4 and 5 together, with one longish terminal hair. Cerci black. Wing-length 2·7–3 mm. Brodick, Arran; Whernside and Austwick, Yorks. (*F.W.E.*).

A male from Corrour, Inverness (*Grimshaw*) is similar, but has the wings whiter by reflected light (almost colourless by transmitted light) and knob of halteres whitish; A.R. 2·5. Another male from Burley-in-Wharfedale, has whiter wings and halteres than the type, but the scutal stripes are separate; A.R. under 2.

S. (P.) calcarata, sp. n. ♂. Head yellow, darker above; antennae and palpi black. A.R. about 2, shaft not unusually stout. Thorax yellow, scutal stripes, postnotum and sternum black; whole surface dull and slightly dusted with grey. Abdomen dark brown, hind margins of tergites darker; hypopygium with longer anal point and more basally placed basal lobe than in the last two species. Legs rather dark brown; front tarsi with distinct beard, longest hairs 3–4 times diameter of segments; outer spur of middle tibia present, but scarcely half as long as the inner; last segment of all tarsi somewhat compressed laterally. Wings almost as in the last species, but rather more milky and costa less produced; costa, R_1 and R_{4+5} somewhat darkened. Halteres yellow, base of stem blackish. ♀. Thorax almost all yellow; scutal stripes and sternum scarcely darker than ground-colour; no black dot at posterior end of lateral stripes; postnotum dark brown, yellow at base. Last segment of antenna fully as long as the three preceding together; single terminal hair rather short. Cerci yellowish. Wing-length 3 mm.

Lake Windermere, 3 ♂, 2 ♀ taken on yacht windows, 9.vii.1923 (*F.W.E.*).

S. (P.) barbimanus, sp. n. ♂. Head yellow, palpi and antennae black. A.R. about 2·5. Thorax yellow; postnotum, sternum and a spot on pleurae black; scutal stripes reddish, posterior end of each black, that of the median stripe more narrowly so; whole surface dull. Abdomen entirely black. Hypopygium almost as in *S. stratiotis*, Kieff.; anal point shortly triangular. Legs yellow, but front tibiae and tarsi and upper surface of front femora black; L.R. about 0·75; front tarsus with long beard, especially on outer side of segments 2–4; middle tibia with only one spur; last segment of all tarsi somewhat compressed. Wings strongly milky, anterior veins hardly darkened. Costa distinctly produced; R_{2+3} ending midway between R_1 and R_{4+5}. Halteres yellow. Wing-length 3·5 mm. Putney, S.W. London, 27.viii.1926, 1 ♂ (*F.W.E.*).

S. (P.) sordidella, Zett. (*exspatiens*, Walk.; *albinervis*, v.d.W.; *psilopterus*, Kieff.; *luteolus*, Goet.). Very similar to the last in colour, differing as follows :— Scutal stripes usually all black, middle stripe in ♀ often light brown, sometimes also lateral stripes. A.R. about 2·0. Front tibiae brownish. R_{2+3} ending at about one-third of the distance between R_1 and R_{4+5}. Anal point longer. No front tarsal beard in ♂. Rather common.

One of the females in the British Museum has abnormal antennae with 11 segments.

Variety ?—Much darker, thorax of ♂ mainly black, scutal stripes of ♀ dark brown; wings less strongly milky; costa distinctly produced; R_{2+3} longer, ending in ♂ only just before midway between R_1 and R_{4+5}. Basal lobe of ♂ hypopygium rather large and squarish, as figured by Goetghebuer for *P. stratiotis*, Kieff. Scilly Is. (*Jenkinson*); Whernside (*F.W.E.*).

Variety ?—Very similar to the last, but front tarsus of ♂ with short beard on segments 2–4 (longest hairs about twice as long as diameter of segments), and hypopygium differs, the basal lobe being more rounded and extending further along the side-piece; anal point more slender; wings only very slightly milky. Wood Walton, Hunts. (*Rothschild*); Lake Windermere (*F.W.E.*).

S. (P.) limbatella, Holmgren. Similar to the last two, but smaller (wing-length 2·5–2·8 mm.); lobe of ♂ wing less prominent; A.R. 1·6–1·8; scutal stripes of ♀ dark brown to blackish. R_{2+3} ending at one-third the distance between R_1 and R_{4+5}. Llyn Gwynant, Carnarvon and Correin Lochan, Arran (*F.W.E.*); Catacol, Arran (*Waterston*). The specimens in the British Museum from Scotland and Spitsbergen agree rather closely.

S. (P.) stratiotis, Kieff., 1908*b* (?). Thorax of ♂ yellow, scutal stripes varying from brown to black, sometimes brown with posterior ends of lateral pair black; postnotum and sternum black. A.R. 1·3–1·6; last segment pointed, but rather swollen some distance before tip. ♀. Almost entirely yellow, sternum and scutal stripes scarcely darker, but a black dot at posterior end of each lateral stripe; postnotum mainly black; cerci yellow. Last antennal segment almost as long as three preceding together, with two rather short terminal hairs. Wing-length about 2·5 mm. Putney (*F.W.E.*); Oxford (*Hamm*). Perhaps only a form of *S. sordidella*.

S. (P.) sp. inc. ♀. Smaller than any of the above (wing-length 2 mm.), but similar to the last as regards antennae, pulvilli and wings. Manchester (*Britten*).

S. (P.) turfacea, Kieff., 1924*c*. ♂. Dull black, including antennae, palpi, legs and halteres. A.R. about 1·3; last segment pointed, but somewhat swollen before the tip, with one straight apical hair and about 6–8 rather long curly hairs around tip. Hypopygium without distinct anal point, though the ninth tergite itself is triangular; basal lobe squarish, much as in *S. stratiotis*. Front tarsi without beard; posterior tibiae and tarsi with rather long hair. Pulvilli moderately broad, not much shorter than claws; empodium longer than claws; spur of middle tibia very short. Wings (Plate XVII, fig. 15) milky-white. Costa slightly produced; R_{2+3} reaching costa half-way between R_1 and R_{4+5}, *r-m* not very oblique; *fCu* a short distance beyond *r-m*; Cu_2 curved; lobe rather obtuse. Wing-length 1·7 mm.

♀. Antennal segments 3–5 scarcely longer than broad, oval, not constricted at either end; 6 much stouter, but not as long as 4 and 5 together, hairs at tip as in ♂. Face yellow. Scutum yellow, stripes separate and black, middle stripe slightly more brownish. Scutellum, venter and halteres yellow. Costa rather more produced than in ♂ and lobe rather more obtuse. Halteres pale.

Denny Bog, New Forest, 19.v.1911, 6 ♂♂ (*Rev. A. E. Eaton*); Brothers' Water, Westmorland, 6 ♂♂ (*F.W.E.*). Llanberis Pass, 1 ♀ and Killarney, 1 ♀ (*F.W.E.*). This small species is evidently not nearly related to the others; it seems to connect *Psectrocladius* with *Eukiefferiella*, through such species as *S. curtistylus*, Goet.

Subgenus **Orthocladius** (v.d.W.) Kieff.

(Including *Dactylocladius*, Kieff., *Chaetocladius*, Kieff., and *Dyscamptocladius*, Tnm.)

Eyes bare. Small tarsal spurs usually present. Pulvilli usually absent (occasionally present and very small). Wing-membrane with or without very small microtrichia. Squama usually with a complete fringe (occasionally bare or with fringe reduced to a few hairs). R_{2+3} well separated from R_{4+5} and ending separately in costa, usually at or before midway between R_1 and R_{4+5}. Base of cubital fork rather variable in position, usually below or only slightly beyond *r-m*. Cu_2 usually straight or almost so, but its extreme tip usually curved forwards and not reaching wing-margin.

Van der Wulp in introducing this genus mentioned ten species, which agree in having bare wings, uniformly coloured tibiae and a straight Cu_2; some of them have hairy eyes or distinct pulvilli, but Kieffer in 1906 (*Bull. Soc. Sci. Brux.*, 30, p. 356) restricted the genus to those species with bare eyes, no pulvilli and a short empodium, and designated *sordidellus*, Zett., as the type species. This designation was rather unfortunate, because *sordidellus* has been interpreted in various ways, and an examination of the type shows it to have distinct pulvilli and to belong to Kieffer's *Psectrocladius*. It is difficult to say precisely what Kieffer understood by *sordidellus*, but judging from the manner in which he restricted *Orthocladius* he may have had a species allied to *oblidens*, Walk. Coquillett (1910), apparently ignorant of Kieffer's designation, chose *stercorarius*, De G., as the genotype. In this connection it should be said that De Geer's *stercorarius* is certainly a *Smittia*, the same as *byssinus*, Schrank, but that van der Wulp (following Schiner) had wrongly identified *stercorarius*. Again, it is impossible to be certain what species Schiner and van der Wulp understood by this name, but assuming it was one with white wings and dark halteres, it probably belonged to the group of *O. oblidens*, Walk. All things considered, therefore, it seems best to regard *O. oblidens* as the genotype, although it was not mentioned by name at the time of the erection of the genus.

Similar difficulties beset the interpretation of the name *Dactylocladius*, which was introduced for species with a well-developed empodium but no pulvilli. The name was first published by Kieffer in the *Genera Insectorum* (May 1906), four species being mentioned, but the genotype not being selected. In *Zeitschr. f. Wiss. Insektenbiol.* 2, p. 145 (June 1906) *O. kervillei*, Kieff., was indicated as the type, but in *Ann. Soc. Sci. Brux.*, 30, p. 356 (Sept. 1906) *O. brevicornis*, Kieff. (described in the same issue), was indicated. In placing *kervillei* in *Dactylocladius*, Kieffer was probably relying on his description, which mentioned the empodium, but not the eyes. It is almost certain that *kervillei* is synonymous with *Cricotopus vitripennis*, Mg., which is a common coastal species breeding in brackish or salt water; in his original description Keiffer no doubt overlooked the pubescence of the eyes, because up to 1906 he was not aware of this character, and regarded the South American *T. fissicornis* as abnormal. *O. kervillei* therefore cannot be accepted as the type of *Dactylocladius*, and we

must take *O. brevicornis*; the description of this species was not published until four months after the publication of the name *Dactylocladius*, but from internal evidence it would seem that the *Annales* paper was written first. This species has not been identified since; it was described as having punctate wings (perhaps indicating presence of microtrichia?) but otherwise seems similar to the other small species of *Orthocladius* (Group D of our present arrangement). Many of the species subsequently placed by Kieffer in *Dactylocladius* belong to this same group, and the name may be applied to this group pending the identification of *D. brevicornis*.

The name *Chaetocladius* was introduced by Kieffer (1911*b*), as a subgenus of *Orthocladius*, for those species with distinct microtrichia on the wings. Six species were briefly diagnosed, but it is impossible to identify any of them. I therefore base my conception of the genus on *O. perennis*, Mg., a common species which must have been known to Kieffer and may have been one of those originally included.

Dyscamptocladius was based by Thienemann (1921) on larval and pupal characters; he designated *Camptocladius vitellinus*, Kieff., as the genotype. From the original description of this species it is clear that it is not a true *Camptocladius*, but I am unable to identify it. I have received from Prof. Thienemann two other species which he places in *Dyscamptocladius*; both belong to the same group as *O. perennis*, Mg., and it would seem therefore that his conception of *Dyscamptocladius* would include if not coincide with *Chaetocladius* as understood by me.

The very numerous British species of *Orthocladius* may be arranged in six groups, the first, third, and fourth of which correspond more or less with *Chaetocladius*, *Orthocladius*, s. str., and *Dactylocladius*; the fifth and sixth include a few small and rather aberrant species. It is possible that some of these groups should be regarded as subgenera; they are almost as well defined as the other groups which have been admitted as subgenera in this paper. The division on wing-colour is rather easy to apply in practice, and is perhaps more significant than would appear at first sight, because it has been found that the colour depends on the microscopic structure of the wing. When a strongly milky-white wing (brown by transmitted light) is examined under a one-sixth objective it is barely possible to distinguish closely placed minute dots, less than 0·5 μ apart; a rather less milky wing will show these dots 0·5–1 μ apart, and such wings will always show a faint brown or purplish tinge by transmitted light. When the punctuation is a little coarser (dots about 1·5 μ apart) the wing will appear quite colourless, or faintly greyish, by transmitted light, but no distinct setae or "microtrichia" are visible even under a high power; this is the condition in the males of Group A. If the punctuation is a little coarser still (dots 2–2·5 μ apart, as in the females of Group A) it is possible to distinguish fine microtrichia (2–4 μ long) arising from the punctures, the wing still appearing greyish.

Key to Groups.

1. Wings colourless by transmitted light . . . . . 2.
   Wings at least faintly tinged with brown or purplish by transmitted light . 3.
2. *An* reaching far beyond *fCu* . . . . . *Group A.*
   An reaching only slightly if at all beyond *fCu* . . . . . *Group B.*
3. *An* reaching beyond (usually far beyond) *fCu*; Cu_2 almost straight . . . 4.
   An not reaching beyond *fCu*; Cu_2 more or less bent . . . . . 5.
4. Lobe of wing more or less prominent (in ♂); *fCu* scarcely beyond *r-m*; empodium very short, especially in ♂ . . . . . *Group C.*

Lobe of wing right angled or obtuse; *fCu* beyond *r-m*; empodium rather long . . . . . *Group D.*

5. Lobe of wing prominent; R_{2+3} ending nearer R_1 . . . . . *Group E.*
   Lobe of wing obtuse; R_{2+3} ending nearer R_{4+5} . . . . . *Group F.*

Group A.

(*Chaetocladius*, Kieff.; *Dyscamptocladius*, Tnm.)

Wings colourless or faintly greyish by transmitted light, fine microtrichia distinguishable (at least in ♀) under a high power. Costa only slightly produced. R_{4+5} ending a little beyond level of tip of Cu_1; *r-m* distinct, almost transverse; *An* reaching far beyond *fCu*, which is usually below or hardly distal to *r-m*. Wing broad at base, lobe right-angled or only slightly produced in ♂. Squamal fringe complete. A.R. 1·5 or more. Antennae of ♀ 6 or 7 segmented, last segment not longer than two preceding together; sense-bristles simple. Scutellum slightly and uniformly shining, smooth bare area at its base barely distinguishable. Hypopygium (except in *O. excerptus*) with bare anal point. Empodium distinct in both sexes. Claws of ♂ small and not very blunt. Wing-length 4–5 mm.

I am acquainted with six British species, four of which are very similar.

1. Thorax dull . . . . . 2.
   Thorax rather brightly shining . . . . . *excerpta*, Walk.
2. Thorax with two conspicuous silvery-grey stripes . . . . . *melaleuca*, Mg.
   Thorax not so marked . . . . . 3.
3. Halteres yellowish in both sexes . . . . . 4.
   Halteres black, at least in ♂ . . . . . 5.
4. Anal point (♂) short and slender . . . . . *perennis*, Mg.
   Anal point long and stout . . . . . *suecica*, Kieff.
5. Pulvilli absent as usual . . . . . *pigra*, Goet.
   Small pulvilli present . . . . . *dissipata*, sp. n.

S. (O.) melaleuca (Mg.) (*argentatus*, Goet.). Black, but with conspicuous silvery-grey dusting on shoulders, on pre-scutellar area, and on the narrow lines between the scutal stripes. Halteres pale. A.R. about 1·5. Apparently rare. Snowdon and Dolgelley (*Verrall*); Dart Head, S. Devon (*F.W.E.*); Crosby, Lancs. (*Grensted*); Bacup, Lancs. (*Britten*).

S. (O.) perennis (Mg.) (*novatus*, Walk.; *setiger*, Kieff., *pentachaetus*, Kieff.; *polychaetus*, Kieff.; ? *trinotatus*, Kieff., 1916). Black; dull; grey dusting more or less obvious (especially in ♀) on shoulders, prescutellar space, and between scutal stripes, but not conspicuously silvery as in the last species. Halteres pale in both sexes. A.R. about 1·5. Hypopygium (fig. 6*a*) with anal point very short. Antennae of ♀ 7-segmented, last segment with short pubescence on the underside only, and in addition with 4–5 long curled hairs, two of which are apical; intermediate segments with long slender sense-bristles. Very common.

S. (O.) suecica, Kieff., 1916. Very similar to the last, but hypopygium (fig. 6*b*) with long anal point; basal lobe rather differently shaped, styles less swollen. Female antennae (in the single specimen available) 7-segmented as in *S. perennis*, but sense-bristles shorter, last segment more uniformly pubescent and with only two rather longer hairs, both at the tip. Snailbeach, Salop (*F.W.E.*); Ilkley, Yorks. (*Grace*); Denton, Lancs. (*Britten*).

S. (O.) pigra (Goet.). Dull black, like the last two; grey dusting on thorax less obvious. Halteres of ♂ blackish, though those of ♀ may be yellow. A.R.

1·7–2·0. Costa only slightly produced. No obvious trace of pulvilli. Hypopygium (fig. 6*d*) resembling that of *S. perennis*, but basal lobe quite differently shaped, anal point longer. Antennae of ♀ only 6-segmented, sense-bristles short, terminal segment finely pubescent all over, longer than 4 and 5 together, and with only two rather longer hairs at tip. Common.

S. (O.) dissipata, sp. n. Similar to the last, but halteres black in both sexes; thorax with distinct grey dusting on shoulders and between stripes, most noticeable in ♀. Antennae of ♀ 6-segmented, as in *S. perennis*, but segment 6 not longer than 4 and 5 together. Wings (Plate XVII, fig. 17) with costa more distinctly produced. Small pulvilli present, about one-third as long as the claws. Hypopygium (fig. 6*c*) rather different: anal point very slender and delicate, basal lobe smaller, style rather differently shaped. Scilly Is. (*Jenkinson*); Ilkley (*Grace*); Flannan Is. (*Grimshaw*); Stickle Tarn, Westmorland (*F.W.E.*).

This species is of interest as it provides another instance of the small value which is to be attached to the presence or absence of pulvilli in this subfamily. It is obviously very closely related to *O. piger*, in which pulvilli are absent, and has much less affinity with *Psectrocladius*.

S. (O.) excerpta (Walk.). Thorax very distinctly shining all over; ground-colour of scutum yellowish, the rest black; scutal stripes separate in ♀ and in type ♂, but fused in other ♂♂; pronotum yellowish. A.R. only about 1·2. Antennae of ♀ 6-segmented; 2 hardly constricted; 3–5 oval, with very short, simple sense-bristles and long verticils; 6 scarcely as long as 4 and 5 together, not sharply pointed, pubescence especially abundant on underside and fully as long as the diameter. Punctures at bases of mesonotal hairs unusually large and conspicuous, especially those on shoulders, which are more numerous than usual and almost surround the small humeral pits. Abdomen blackish. Hypopygium (fig. 6*e*): anal point hairy; basal lobe with fringe of long hairs. Legs dark brownish; tibiae and tarsi without long hairs; no tarsal spurs; fourth tarsal segment on all legs distinctly longer than fifth. Wings with the base rather conspicuously yellow. R_{2+3} reaching to almost midway between R_1 and R_{4+5}; costa ending abruptly at tip of R_{4+5}; *fCu* somewhat variable in position, but always distinctly beyond *r-m*. Lobe slightly produced in ♂, slightly obtuse in ♀. Halteres and squamae yellow. Wing-length about 3 mm. Apart from Walker's type I have only seen this species from Dovedale, Derbyshire (*Verrall*) and Temple Sowerby, Westmorland (*F.W.E.*). In several respects it is very distinct from the five noted above. The hypopygium resembles that of some species of Group C, or of *Trichocladius*, Group B.

Group B.

Wings colourless or faintly greyish by transmitted light; fine microtrichia usually distinguishable under a high power. Costa usually very distinctly produced. R_{4+5} ending above or a little beyond level of tip of Cu_1; *r-m* very oblique, almost continuing the direction of the basal part of *M*; *An* scarcely reaching beyond *fCu*, which is very distinctly distal to *r-m*; Cu_2 often rather wavy. Wings narrower than in Group A; lobe rounded, usually obtuse. Squamal fringe less complete than in Group A, sometimes reduced to a few hairs or even absent. A.R. 1·1–1·8. Last segment of ♀ antennae at most as long as the two preceding together. Scutellum as in Group A. Empodium distinct. Claws of ♂ small and more or less pointed.

A group of species which occupy an intermediate position between *Orthocladius* (Group A) and *Limnophyes*. In most of the known females the sense-

FIG. 6.—♂. Hypopygium (right half, from above) of species of *Spaniotoma*, subgenus *Orthocladius*. a, *S. perennis*, Mg. b, *S. suecica*, Kieff. c, *S. dissipata*, sp. n. d, *S. piger*, Goet. e, *S. excerpta*, Walk. f, *S. subvernalis*, sp. n. g, *S. nidorum*, sp. n. h, *S. feminea*, sp. n. i, *S. tuberculata*, sp. n. j, *S. illimbata*, sp. n. k, *S. oblidens*, Walk. l, *S. rubicunda*, Mg. m, *S. thienemanni*, Kieff. (showing variation in shape of style in three specimens of same batch). n, *S. frigida*, Zett. o, *S. gracei*, sp. n. p, *S. dentiforceps*, sp. n. q, *S. minor*, sp. n. r, *S. tripilata*, sp. n. s, *S. apicalis*, Kieff. t, *S. verralli*, sp. n. u, *S. ilkleyensis*, sp. n. v, *S. devonica*, sp. n. w, *S. flexuella*, sp. n.

bristles of the antennae are forked, a peculiar character not found in any other species of the subfamily. Several of the species are known to have terrestrial larvae, and this may be the case with all members of the group. On the other hand, no terrestrial larvae are known in other groups of *Orthocladius*. I am acquainted with about a dozen British species.

1. Body mainly yellow; squama almost or quite bare . . . . . 2.
   Body darker (at least in ♂); squama fringed . . . . . 3.
   Thorax shining black; squama quite bare . . . . . *illimbata*, sp. n.
2. Whole body yellow; squama quite bare . . . . . *icterica*, Mg.
   Scutal stripes distinct, brown; squama with 1–2 hairs . . *bipunctella*, Zett.
3. Wings greyish by reflected light . . . . . 4.
   Wings whitish by reflected light; ♂ all black, ♀ all yellow . . . . . 9.
4. Costa rather strongly produced . . . . . 5.
   Costa only slightly produced . . . . . 6.
5. Antennae (♀) longer, halteres yellow . . . *subvernalis*, sp. n.; *vernalis*, Goet.
   Antennae (♀) shorter, body all black . . . . . *furcata*, Kieff.
6. Thorax (♂) yellow with black scutal stripes; anal area of wing slightly developed, very obtuse . . . . . *tuberculata*, sp. n.
   Thorax (♂) mainly or all black; anal area of wing well developed, rounded 7.
7. Scutellum and shoulders (♂) yellowish . . . . . *sima*, sp. n.
   Thorax (♂) all black . . . . . 8.
8. Thorax rather shining; antennal plume normal . . . . *nitidicollis*, Goet.
   Thorax dull; antennal plume reduced . . . . . *feminea*, sp. n.
9. Costa distinctly produced . . . . . *xanthogyne*, sp. n.
   Costa scarcely produced; thorax unusually hairy . . . . *nidorum*, sp. n.

The species seem to fall into three natural series, according to the form of the hypopygium and of the sensory bristles on the female antenna :

1. The *furcata* series. Sensory bristles of ♀ antenna forked near base. Hypopygium with rather large, rounded, bare basal lobe; longish, bare anal point, and simple style. Costa very distinctly produced. Microtrichia of wings quite distinct, at least in ♀. This series includes the first four or five species mentioned below, and one other described by Kieffer (*O. divisus*, 1921*c*). It is of interest to note that although the species seem quite distinct they show practically no difference in hypopygial structure.

2. The *muscicola* series. Sensory bristles of ♀ antenna bifid or trifid towards tip. Hypopygium with very small basal lobe, broadly triangular anal point, and flange on style. Costa only slightly produced. Microtrichia of wings less distinct than in series *a*. This includes *S. muscicola*, Kieff. (1906*b*), *S. trifida*, Kieff. (1921*c* and 1923*c*), *S. xanthogyne*, sp. n., and probably also the three species described below which have a hypopygium similar to *S. xanthogyne*.

3. The *nitidicollis* series. Sensory bristles of ♀ antenna simple and hypopygium different, no flange on style. The two species (*nitidicollis*, Goet., and *illimbata*, sp. n.) approach *Limnophyes*. *O. femineus*, sp. n.; is perhaps related to these species.

S. (O.) icterica (Mg.) (*pertenuis*, Walk.; *ochraceus*, Goet.). Body all yellow, legs and antennae darker, but first antennal segment yellow. Squama quite bare. Costa strongly produced; *fCu* only a little beyond *r-m* R_{4+5} somewhat wavy, Cu_2 strongly so. A.R. 1·5–1·7. Antennae of ♀ 6-segmented, 3–5 each with a long neck; sense-bristles mostly bifid near their base, but some appearing simple. Hypopygium as in *S. vernalis*, with longish anal point and rounded basal lobe; no subapical expansion on style. Widely distributed but

nowhere common; could not be confused with any other species owing to its completely yellow colour in both sexes.

S. (O.) bipunctella (Zett.). Very similar to the last, and possibly only a variety of it, the wings, male hypopygium and female antennae having the same structure, but male with scutal stripes and mesosternum brown, postnotum blackish; lateral scutal stripes usually with blackish dot at posterior end; female with scutal stripes distinctly darker than ground-colour, postnotum dark brown; and both sexes having one or (usually) two small hairs on margin of squama. Arthog and Dolgelley (*Verrall*); Llyn Gwynant, Carnarvon, and Gormire, Yorks. (*F.W.E.*); Bonawe, Argyll (*Waterston*); Logie, Elgin (*Jenkinson*).

S. (O.) vernalis (Goet.). Structurally similar to the last two, but somewhat smaller and of stouter build; cubital fork rather shorter; body and legs of ♂ almost all black, and even the halteres darkened, though the scutellum is usually pale; thorax of ♀ largely dark brown; A.R. 1·2–1·4; segments 3–5 of ♀ antenna with shorter necks; and squama with 4–5 hairs. Common.

S. (O.) furcata, Kieff., 1916. ♀. Head black, including antennae and palpi. Antennae 6-segmented; 3–5 spindle-shaped, without distinct necks, 6 hardly as long as 4 and 5 together; sense-bristles mostly forked near the base, as in the last three species, but a few of them appear to be simple. Thorax entirely black and rather distinctly shining. Abdomen, legs and halteres blackish. Wings with the costa strongly produced; R_{4+5} almost straight, Cu_2 also straighter than in the last three species; membrane greyish, anterior veins darkened. Squama with 4–6 hairs. Wisley, Surrey, iv.1922; numerous ♀ but no ♂ reared from larvae attacking *Primula* roots (*G. Fox-Wilson*). Lewes, Sussex, xii.1913; ♀ reared from larvae attacking roots of greenhouse plants (*W. E. Nicholson*). Cheshunt, Herts., x–xii.1922, ♀ reared from larvae in cucumber plants in pots; also in one case from a larva actually found burrowing in the centre of the stem of a seedling tomato (*E. R. Speyer*).

S. (O.) subvernalis, sp. n. ♂. *Head* blackish, antennae and mouth-parts dark brown. A.R. about 1·3, last segment somewhat swollen before tip and moderately pubescent. *Thorax* slightly shining, with very slight pruinescence. Pronotum brownish. Scutum yellowish on shoulders; stripes blackish, just separate in front but fused behind; prescutellar area all dark. Scutellum yellowish. Pleural membrane yellowish. *Abdomen* brownish. Hypopygium (fig. 6*f*) with long, slender, bare anal point; styles much broadened in middle, almost triangular; basal lobe prominent; simple. *Legs* brownish. No tarsal beard; hair on posterior tibiae short. Fourth tarsal segment on all legs somewhat longer than fifth. Empodium very short, no pulvilli. *Wings* colourless, veins scarcely darkened. Costa strongly produced; R_{2+3} touching costa at one-third, then gradually fusing with it; *r-m* almost horizontal; *fCu* well beyond *r-m*; Cu_2 gently bent beyond middle; *An* reaching a short distance beyond *fCu*. Lobe right-angled, but well rounded off at corner. Squamal fringe slight. Halteres yellowish. Wing-length about 2·5 mm. Windermere, vi.1929, 1 ♂ (*F.W.E.*). Apparently related to *S. vernalis*, Goet., the venation being very similar, but the anal lobe is better developed than in that species (or any other of this group) and the shape of the style appears very distinctive.

S. (O.) tuberculata, sp. n. ♂. Head dark, including antennae. A.R. 1·1. Extreme tip of antenna pointed, with a few short hairs. Thorax with yellow ground-colour; scutal stripes separate, blackish and rather distinctly shining; postnotum, sternum, and a small patch on pleurae below wings blackish. Abdomen blackish. Hypopygium (fig. 6*i*). Anal point short, broadly tri-

angular, bare. Coxite with a small rounded tubercle representing basal lobe. Style broad, with a large flange on inner dorsal aspect; terminal spine single, rather strong. Legs dark brown. Wings greyish by reflected light, microtrichia just distinguishable under a magnification of 300. Costa only slightly produced. R_{2+3} ending at one-third of the distance between R_1 and R_{4+5}; *fCu* much beyond *r-m*; Cu_2 with its apical fourth distinctly bent down. Anal area only slightly developed, very obtuse. Squama with about 6 hairs. Halteres yellow. Wing-length 2 mm. Snailbeach, Salop, vii.1920, 2 ♂♂ (*F.W.E.*).

S. (O.) sima, sp. n. ♂. Head dark, including antennae. A.R. about 1·7. Extreme tip of antenna pointed, with a few short curly hairs. Thorax blackish, scutal stripes distinctly shining, rest of scutum and pleurae slightly dusted with grey; pleural membrane and scutellum rather dull yellowish. Dorsocentral hairs biserial. Abdomen blackish, hypopygium constructed almost exactly as in the last species, but anal point not quite so blunt, and basal tubercle perhaps somewhat more hairy. Femora dark brown, tibiae and tarsi lighter. Wings greyish by reflected light, but punctuation a little finer than in the last species and definite microtrichia not distinguishable. Costa slightly produced. R_{2+3} ending a little before midway between R_1 and R_{4+5}; *fCu* beyond *r-m*, but not quite so distant as in the last species; Cu_2 only gently curved, not bent down at tip. Anal area fairly well developed, rounded but not very obtuse. Squama completely fringed (about 10 hairs). Halteres brownish yellow. Wing-length 2·5 mm. Baldock, Herts., v.1918, 1 ♂ (*F.W.E.*).

S. (O.) xanthogyne, sp. n. ♂. Entirely black, except for the tibiae, tarsi and halteres, which are dark brown. A.R. about 1·8; tip of antenna blunt, with a few short straight hairs. Thorax scarcely shining, with slight grey dusting visible when seen from in front. Dorsocentral hairs irregularly biserial. Scutellum with a row of about 8–10 marginal hairs. Hypopygium almost exactly as in *S. tuberculata*; inner flange of style perhaps less developed, and tubercle representing basal lobe perhaps slightly less prominent. L.R. about 0·65; no tarsal beard; fourth tarsal segment on all legs distinctly longer than fifth; empodium not more than half as long as claws, which are blunt-tipped. Wings (Plate XVII, fig. 19) distinctly white by reflected light, but without any trace of brown colour by transmitted light; surface coarsely punctate, but microtrichia not distinguishable. Costa rather more distinctly produced than in the last two species; R_{4+5} rather wavy and ending immediately beyond level of tip of Cu_1; R_{2+3} ending just before midway between R_1 and R_{4+5}; *fCu* much beyond *r-m*; Cu_2 with its apical fourth bent down; anal area rather well developed, rounded but not obtusely so. Wing-length about 2·3 mm.

♀. Entirely pale yellow, only the legs more brownish, and last segment of antennae rather dark brown. Antennae 6-segmented; 2 not constricted; 3–5 rather shortly oval; 6 not much longer or thicker than 5, with rather scanty short pubescence. Sense-bristles short, but irregularly bifid or trifid from about the middle, as figured by Kieffer for *O. muscicola* (this can only be seen clearly in a mount). Wings much as in ♂, but broader (as usual) and anal area more obtuse.

Knebworth, Herts., 4–6.v.1923; great numbers of both sexes in one small corner of a wood (*F.W.E.*).

S. (O.) nidorum, sp. n. ♂. A black species, with dark brown legs and halteres, and wings white by reflected light, as in the last; hypopygium (fig. 6*g*) also quite similar. Differs from *O. xanthogyne* as follows:—Hair on thorax

unusually long and dense, the dorsocentral hairs occupying rather wide stripes, and even between the bare scutal stripes are triserial, instead of irregularly uniserial or biserial as usual; scutellar hairs numerous (about 20), long and bristly, not arranged in a single marginal row. Scutum rather distinctly shining, without grey dusting even between the stripes. Costa scarcely produced; cubital fork perhaps a little narrower at base. Stem-vein with 2–3 hairs instead of the usual one; squamal fringe long and dense. Lobe slightly but distinctly produced. Wing-length about 1·8 mm. Oxford, 1 ♂ (*A. H. Hamm*); larva found 24.xi.1925 in blackbird's nest in Museum Parks, adult emerged 7.vi.1926.

S. (O.) nitidicollis (Goet, 1913*a*). ♂. Body and legs almost entirely blackish, only pleural membrane brownish-yellow, and halteres dark brown. Thorax distinctly shining, no grey dusting on scutum. Anal area of wing rather well developed, almost right-angled. Hypopygium distinctive. Anal point rather short but narrow; styles hairy, without extensive flange and with two terminal spines, one dark and the other pale; coxite with a small, bare, thumb-like projection at base, much resembling that seen in *S.* (*Smittia*) *stercoraria*.

♀. Ground-colour of scutum light-brownish, but stripes shining black as in ♂, and almost fused. Sense-bristles of antennae long, slender and simple; last segment with a pair of sense-bristles near base but no verticil; 3–5 with short necks. Venation as in ♂, costa scarcely produced. Wing-length 2·2 mm. Cringle Fields, Manchester, 22.viii.1920, 4 ♂, 1 ♀ (*H. Britten*).

I believe this species is better placed in *Orthocladius* than in *Camptocladius*, under which name Goetghebuer described it.

S. (O.) feminea, sp. n. ♂. Blackish, including antennae, palpi, legs and halteres. General build very slender. Antennae (fig. 8*g*) with the plume reduced to about 4 hairs on each segment (a few more scattered on terminal segment), longest hair less than half as long as antenna; A.R. about 0·7, tip of last (14th) segment clothed with extremely short pubescence for some distance; segment 13 nearly twice as long as broad. Palpi only moderately long, but 4-segmented as usual, 2 a little shorter than 3, 3 shorter than 4. Thorax dull, but not conspicuously pruinose; dorsocentral hairs well developed, uniserial. Hypopygium (fig. 6*h*) with short, broad and rounded anal point; style without distinct flange or subapical projection; lobe of coxite large and somewhat square. L.R. about 0·6; fourth tarsal segment on all legs slightly longer than fifth; claws very small, pointed; empodium not very large, but hardly shorter than claws. Wings narrow, greyish. Costa only slightly produced; R_{2+3} ending a little before midway between R_1 and R_{4+5}; *r-m* long and nearly horizontal, as in other members of this group; *fCu* below middle of *r-m*, fork long and narrow, Cu_2 only slightly curved. *An* longer than in most other species of this group, but ending before middle of Cu_2. Lobe rather well developed, slightly obtuse. Squama pale, with 3–5 short hairs in middle. Wing-length 2·7 mm. Saltesley Moss, Cheshire, 6.xi.1920, 1 ♂ (*Britten*).

This specimen is remarkable for the reduction of the antennal plume. It is just possible that this may be an individual anomaly, but the two antennae are quite alike, and the hypopygium is different from that of any of the other species of this group known to me. A similar reduction of the antennae is shown by some species of *Trissocladius* and by *Tvetenia duodenaria*, Kieff.

S. (O.) illimbata, sp. n. ♂. Black, including antennae, legs and halteres. Scutum somewhat shining. Antennae 14-segmented, A.R. about 1·4; terminal segment slender, pointed, with very little fine pubescence at the tip. Hypopygium (fig. 6*j*) with anal point very broad, its base finely pubescent; lobe of

coxite large, rounded, strongly chitinised and almost bare; style bent at tip, without lateral expansion. Legs with longish hair on posterior tibiae and tarsi; L.R. about 0·6; fourth and fifth tarsal segments subequal, over twice as long as broad; empodium rather short. Wings (Plate XVII, fig. 18) greyish, with practically no milky tinge, very densely punctate but without visible microtrichia even under a high magnification; lobe very slightly developed and obtusely rounded. Costa rather strongly produced. R_{4+5} nearly straight, ending well before wing-tip and above tip of Cu_1; *fCu* only a little beyond *r-m*, which is short and oblique; Cu_2 bent beyond the middle, basal part of fork narrow; *An* straight and scarcely reaching beyond *fCu*. Wing-length 1·7 mm.

♀. Blackish, including knob of halteres; legs and antennae dark brown. Segments 3–5 of antennae oval, with short necks and slender, simple sense-bristles; 6 slender, nearly twice as long as 5, microscopically pubescent, with some longer hairs at tip. Scutum shining black; dorsocentral hairs uniserial. Wings greyish, but without distinct microtrichia. R_{4+5} somewhat waved and lying close to R_2 and the costa. Practically no trace of anal lobe; squama quite bare. Wing-length 1·5 mm. Letchworth, Herts., vi.1917, 1 ♀ and v.1918, 2 ♂♂ (*F.W.E.*).

A rather distinct species on account of its small size and absence of anal lobe and of squamal fringe. Apart from the slightly different venation, the absence of a verticil on the sixth antennal segment of the ♀ excludes it from *Limnophyes*.

Group C.

(*Orthocladius*, s. str.)

Wings at least faintly tinged with brown when viewed by transmitted light; no microtrichia. Costa not or scarcely produced. R_{4+5} ending only slightly if at all beyond level of tip of Cu_1. *An* reaching far beyond *fCu*, which is little if at all distal to *r-m*; *r-m* nearly transverse. Cu_2 nearly straight. Lobe large and more or less distinctly produced, at least in ♂. Squama with complete fringe. A.R. more than 1. Antennae of ♀ 6-segmented, last segment pointed, pubescent all over, and as long as 3–5 together. Scutellum with a smooth bare area at the base, sharply marked off from the dull apical part. Empodium very short, at most half as long as claws, but more distinct in ♀ than in ♂; claws of ♂ rather large, stout and blunt-tipped. Hypopygium usually with hairy anal point, ninth tergite bare. Wing length 3–5 mm.

The species of this group are rather numerous and difficult to identify, as many of them are connected by a series of intergrading forms. Except for the absence of pulvilli they are very similar to *Psectrocladius*; it would not be surprising to discover that the early stages indicate a closer affinity between these than between the groups of *Orthocladius* as here defined. The following key to the British species applies only to the ♂♂; I have not been able to distinguish the ♀♀ satisfactorily. We probably have many more species in Britain.

1. Halteres with knob more or less pale . . . . . 2.
   Halteres entirely blackish . . . . . 7.
2. Thorax dull, scutal stripes not shining and more or less fused . . . . 3.
   Thorax somewhat shining, at least on the scutal stripes . . . . . 4.
3. Front tarsus with distinct beard; A.R. about 2·5 . . . *glabripennis*, Goet.
   Front tarsus without beard; A.R. about 2 . . . . . *thienemanni*, Kieff.
4. Scutal stripes fused; A.R. about 2 . . . . . *oblidens*, Walk.
   Scutal stripes separate; A.R. usually well under 2 . . . . . 5.

5. Fourth segment of posterior tarsi slightly shorter than fifth . *rhyacobia*, Kieff.
   Fourth and fifth tarsal segments subequal . . . . . 6.
6. Basal lobe of hypopygium not free . . . . . *rubicunda*, Mg.
   Basal lobe large and free . . . . . *frigida*, Zett.
7. Costa ending abruptly at tip of R_{4+5}; hypopygium without anal point *gracei*, sp. n.
   Costa slightly produced; style with strong tooth on external margin *dentiforceps*, sp. n.

S. (O.) glabripennis, Goet. ♂. Dull black, scutal stripes not shining; halteres with blackish stem, knob brownish-yellow to dark brown. A.R. about 2·5. The four posterior tibiae and first three segments of all tarsi with long dorsal hair, about 4 times as long as the diameter of the segment. Costa not produced; *fCu* below *r-m*; fork rather narrow. Hypopygium with anal point well-developed but pale, rather hairy; styles truncate at tip; basal lobe prominent, but not free. Hauxton, Cambs., and Hitchin, Herts. (*F.W.E.*); Cambridge (*Jenkinson*); Rostherne, Cheshire (*Britten*).

O. distylus, Kieff., as redescribed by Goetghebuer, is similar but has black halteres and bare anal point.

S. (O.) oblidens, Walk. (*lenzi*, Kieff., 1921*d*). Similar to the above, but scutal stripes rather shining (separate in ♀, in which the ground-colour of the thorax is yellowish); very little grey dusting on scutum. A.R. about 2. Front tarsi of ♂ without long hairs, though they are present on the other legs. Costa very slightly produced (at least in ♀); *fCu* below *r-m*. Knob of halteres clearer yellowish. Hypopygium (fig. 6*k*) much as in the above species, but styles somewhat curved and less square-ended. Common.

This species is subject to some local variation in the length of the hair on the posterior tibiae and tarsi.

S. (O.) thienemanni, Kieff., 1906*a*. Similar to *S. oblidens*, but scutal stripes much less distinctly shining, and not fused in either sex; scutum between the stripes dull yellowish and rather heavily dusted with grey. Hypopygium (fig. 6*m*) differing in form of basal lobe; style with a projection on inner side before tip, variable in size even in specimens from the same batch. Fourth and fifth tarsal segments of each leg subequal in length. Probably common; I have examined specimens from Herts., Beds., Middlesex and Gloucester.

Although I believe this is quite a distinct species, it is not always easy to distinguish from *S. oblidens* on the one hand and *S. rubicunda* on the other. A male (in spirit) received from Thienemann appears to agree with our material.

S. (O.) rubicunda (Mg.) (*incoactus*, Walk.; *persidens*, Walk.; *rivinus*, Kieff.). Lighter in colour than any of the preceding; in some specimens (as for example Meigen's types) the thorax is mainly yellowish-brown, scutal stripes light brown, postnotum alone blackish; in other examples (as Walker's types) the scutal stripes and sternum are blackish and pleurae largely dark; some specimens have a slight grey dusting on the scutum, which is absent in others, the scutum then being distinctly shining. Dorsocentral hairs fewer and shorter than usual, punctures small. A.R. varying from 1·3–1·7; plume dark or indistinctly paler at tip. Hypopygium (fig. 6*l*): style somewhat curved, projection on inner side before tip only slightly developed. Fourth segment of posterior tarsi slightly longer than fifth. Wings with the anal lobe less developed than in any of the preceding, right-angled or very slightly produced. Common.

S. (O.) rhyacobia, Kieff., 1911*b*. Very similar to *S. rubicunda*, but darker, antennal plume whitish apically, and fourth segment of posterior tarsi slightly

but distinctly shorter than fifth Hypopygium almost as in *S. rubicunda*, but style somewhat truncate at tip, as in *S. oblidens*, anal point a little more slender than in either. A specimen received from Thienemann agrees with our material. Ilkley (*Grace*); Arran (*F.W.E.*).

S. (O.) frigida (Zett.). Very similar to *S. oblidens*, but scutal stripes in ♂ often separate; shining area at base of scutellum less developed; A.R. about 1·7; hypopygium (fig. 6*n*) with basal lobe large and free; and hair on tibiae and tarsi short. Ilkley (*Grace*); Arran, Teesdale and Whernside (*F.W.E.*); Crowborough (*Jenkinson*).

Although Zetterstedt had confused several species under the name *Ch. frigidus*, the type from Greenland belongs to this group of *Orthocladius*, and the hypopygium as figured by Lundström in his paper on Arctic Siberian Nematocera agrees fairly well with our material of this species.

S. (O.) gracei, sp. n. ♂. Blackish, including legs and halteres, only the pleural membrane pale. Scutum somewhat dusted with grey between the stripes, which are slightly shining. Shining area at base of scutellum less developed than in *S. oblidens*. A.R. about 1·8. Middle tibiae apparently with only one spur. Fourth segment of posterior tarsi slightly longer than fifth, slender and cylindrical as usual. Hypopygium (fig. 6*o*) distinctive in having no anal point; basal lobe thumb-like, free; styles swollen in middle on inner side. Wings (Plate XVIII, fig. 1) only slightly milky by reflected light, light purplish-brown by transmitted light. Costa ending abruptly at tip of R_{4+5} and unusually short, its termination slightly before level of tip of Cu_1. R_{2+3} ending just beyond one-third of the distance between R_1 and R_{4+5}. Cubital fork more widely open than in *S. oblidens* and its allies, *fCu* somewhat beyond *r-m*; lobe only slightly produced. Wing-length about 3·5 mm. Ilkley, Yorks. (*Grace*).

The hypopygium of this species is much like that of *Cardiocladius capucinus*.

S. (O.) dentiforceps, sp. n. ♂. Dull black, including femora and halteres; tibiae and tarsi brownish. A.R. about 1·6. Palpi slender and 4-segmented as usual. Thorax with very slight grey dusting; scutellum with a large shining area at base as usual in this group. Hypopygium (fig. 6*p*) remarkable on account of the form of the styles, which are triangular, with a long erect tooth in the middle of the outer margin; basal lobe small; anal point very short. Wings with a very slight milky tinge by reflected light, purplish-brown by transmitted light. R_{2+3} ending just before midway between R_1 and R_{4+5}; costa rather distinctly produced; *r-m* rather more oblique than usual; *fCu* distinctly beyond *r-m*; Cu_2 somewhat wavy; lobe rather distinctly produced. Wing-length 2·5 mm. ♀. Ground-colour of scutum brownish, but halteres dark as in the ♂. Antennae as in *S. oblidens* and related species.

Burnham Beeches, Bucks., 15.iv.1915, 4 ♂♂ 4 ♀♀; Stickle Tarn, Westmorland, 1 ♂ 1 ♀ (*F.W.E.*). In the peculiar shape of the styles this resembles *S.* (*Trissocladius*) *nigerrima*, Goet., but that species differs in having shorter, stouter palpi (though they have 4 segments and not 3 as stated in the description), larger basal lobe of hypopygium, darker wings with less developed lobe, and A.R. 1·0.

Group D.

(*Dactylocladius*, Kieff.)

Wings brown by transmitted light; no microtrichia. Costa usually rather distinctly produced; R_{2+3} ending at or before midway between R_1 and R_{4+5}. R_{4+5} ending a little before level of tip of Cu_1; *r-m* distinct, almost transverse; *An* usually reaching well beyond

fCu (though often faint apically); *fCu* distal to *r-m*. Cu_2 nearly straight. Lobe right-angled or obtusely rounded, not produced. Squama fringed. A.R. usually less than 1. Empodium distinct, as long as claws or nearly. Wing-length under 3 mm.

A small group, the members of which show a rather close resemblance to species of *Eukiefferiella*, though at the same time it is difficult to draw a clear distinction between this group and the last, *O. rubicundus* in some of its varieties being intermediate.

I am acquainted with six British species, but have been unable to trace undoubted descriptions of five of them in the works of Kieffer and Goetghebuer, and therefore describe these as new.

Key to Species (♂).

1. Wings with a few macrotrichia on membrane at tip . . . *apicalis*, Kieff.
   Wings without macrotrichia on membrane . . . . . 2.
2. Extreme tip of antenna with only 3–4 long curly hairs . . *tripilata*, sp. n.
   Hairs at tip of antenna rather numerous and short . . . . . 3.
3. Costa rather strongly produced; anal point present . . . *verralli*, sp. n.
   Costa not or scarcely produced; no anal point . . . . . 4.
4. Style with subapical projection; basal lobe free . . . . . *minor*, sp. n.
   Style without subapical projection; basal lobe not free . . . . . 5.
5. A.R. about 0·9 . . . . . *ilkleyensis*, sp. n.
   A.R. about 0·6 . . . . . *devonica*, sp. n.

S. (O.) apicalis (Kieff., 1921*c*). ♂. *Head* blackish, including face, antennae and palpi. A.R. about 0·7; penultimate segment fully twice as long as broad; last segment with about 7–10 short hairs at tip, extending back only a very short distance. *Thorax* with yellowish ground-colour, scutal stripes, scutellum, postnotum and sternum black, slightly shining, without obvious pruinescence. *Abdomen* blackish. Hypopygium (fig. 6*s*) without definite anal point; ninth tergite small and triangular; style rather short, with long terminal spine and unusually stout and long pre-apical seta; basal lobe not very prominent. *Legs* light brownish, femora darker. Hind tibiae and tarsi with longish hair. Empodium fully as long as claws. Small round pulvilli present, scarcely half as long as claws. *Wings* (Plate XVIII, fig. 2) milky, anterior veins scarcely darkened. At extreme tip of wing in cell R_5 is a group of about ten macrotrichia on the membrane. Venation as figured. Squama with about 6 hairs. Halteres yellowish. Wing-length about 1·8 mm.

♀. Colour much as in ♂, but scutum more extensively yellow, scutal stripes remaining black. Antennae 6-segmented, 6 about as long as 4 and 5 together, 2 not constricted. Tarsal characters as in ♂. Wings (Plate XVIII, fig. 3) with more numerous macrotrichia at the tip (about 30 in cell R_5 and about 20 in cell M), and in addition with an irregular row extending the whole length of the wing close to the posterior border, also rows on veins M, Cu_1 and Cu_2 (except towards base of these veins), the longest hairs on outer half of Cu_1 on under surface of wing. Venation as in ♂.

Brothers' Water, Westmorland, vi.1929, 1 ♂; Killarney, v.1929, 1 ♀. Witherslack, Westmorland, vi.1929, 1 ♀ (*F.W.E.*).

The presence of hairs on the wing-membrane distinguishes this insect from all others of the genus at present known in Britain. By this feature it might be referred to *Metriocnemus*, yet in almost every other respect it closely resembles the other species of the present group. The ♀ (if correctly associated) is even more remarkable than the ♂ in possessing hairs also on

M and *Cu*; in both sexes the hairs are suberect and have a more rigid appearance than in any true *Metriocnemus*, and the vein *An* is quite bare (in *Metriocnemus* it is almost invariably hairy).

In spite of some discrepancies in the description (chief among which are the statement that the last antennal segment of the ♂ is " nur halb so lang " as 2–13 together, and the omission of any reference to the pulvilli) I think it probable that this is Kieffer's *Metriocnemus apicalis*.* For larvae attributed to *M. apicalis*, Spärck has proposed the new genus *Heterotanytarsus*, on the ground of resemblances to *Tanytarsus* or to the subgenus *Lauterborniella* of *Chironomus*, but the adult *M. apicalis* certainly belongs to the Orthocladiinae.

S. (O.) tripilata, sp. n. ♂. Head dark above, face pale, antennae and palpi dark. A.R. about 0·8, last segment slightly clubbed, extreme tip with only three or four rather long curly hairs (fig. 8*e*). Thorax usually with clear yellow ground-colour and very little grey dusting; scutal stripes, postnotum and sternum black; often the scutellum and prescutellar area of scutum darkened. Abdomen dark brown. Hypopygium (fig. 6*r*) with short anal point; styles without pre-apical tooth on inner side. Legs yellowish, front femora darkened. Hair on posterior tibiae and tarsi not very long (2–3 times the diameter). Empodia nearly as long as claws. Wings (Plate XVIII, fig. 4) with rather strong brown tinge, darker at tip; venation as figured: *An* continued for some distance, but very faintly, beyond *fCu*; lobe almost right-angled. Squama with complete but not close-set fringe. Halteres yellow. Wing-length about 2·2–2·5 mm.

♀. Yellow; scutal stripes light brown; postnotum dark brown. Antennae dark, 6-segmented; segment 2 not constricted, 3 nearly globular, 4 and 5 more oval, with short, simple sense-bristles; 6 hardly as long as 4 and 5 together, not sharply pointed, tip with about three longish curly hairs as in the ♂.

Common; I have examined specimens from numerous localities in Herts., Beds., Cambs., Suffolk, Surrey, Oxford, Yorks., Westmorland and Devon. A rather well-marked species on account of the reduction of the hairs at tip of antenna.

S. (O.) verralli, sp. n. ♂. Head dark above, face and palpi lighter; antennae dark. A.R. about 0·9–1; tip of last segment with a fair amount of short pubescence, not clubbed. Thorax with yellowish ground-colour; scutal stripes, postnotum and sternum blackish; scutum with distinct grey dusting. Abdomen brown, darker above. Hypopygium (fig. 6*t*) with short but distinct anal point; style with long terminal spine, before which on the inner side is a pale tooth-like projection; basal lobe not free. Legs yellowish; tibiae and first tarsal segments of posterior legs with long hairs, 4–5 times diameter of segments. Empodia about half as long as claws. Wings with rather strong brown tinge, darker at tip. Costa rather strongly produced. R_1 less than half as long as R_{4+5}; R_{2+3} ending at about two-fifths of the distance between R_1 and R_{4+5}; *fCu* much beyond *r-m*; Cu_2 almost straight and cubital fork rather wide; *An* continued for some distance, but very faintly, beyond *fCu*; lobe almost right-angled. Squama with complete fringe. Halteres yellow. Wing-length about 2·3 mm. Llangollen, N. Wales, 1 ♂ (*Verrall*).

S. (O.) minor, sp. n. (Verr. MS.). ♂. Blackish; shoulders, scutellum and pleural membrane light brownish. Scutum somewhat pruinescent, especially

* Since this was written Prof. Zavrel has kindly lent me some damaged cotypes of *M. apicalis*. These possess small pulvilli and in other respects rather closely resemble British specimens. Associated with them in the tube was a specimen of *Tanytarsus* (*Stempellina*) sp.

on two spindle-shaped areas on prescutellar area, adjacent to lateral scutal stripes. A.R. about 0·8; last segment pointed, but slightly enlarged before tip, tip with short pubescence extending back for a distance greater than the diameter of the segment (fig. 8*f*). Hypopygium (fig. 6*q*) with large free basal lobe and no anal point; tip of style with slender projection on inner side close to the terminal spine. Legs dark brownish; small spurs present on first two segments of middle and hind tarsi; empodium about half as long as claws. Wings (Plate XVIII, fig. 5) with only a slight and uniform brown tinge by transmitted light. Venation as figured. Anal area well developed, almost right-angled. Squama with complete fringe of about 10–12 closely-set hairs. Halteres yellow. Wing length about 2·3 mm. Dovedale (*Verrall*); Ilkley (*Grace*); Teesdale and Whernside (*F.W.E.*).

S. (O.) ilkleyensis, sp. n. ♂. Very similar to the last, but wings with a rather stronger brown tinge, especially at tip; costa slightly produced; lobe a little more obtuse; *An* with its tip fainter. A.R. about 0·9. Hypopygium (fig. 6*u*) without anal point, as in the last species, but basal lobe not free, and style quite different. Ilkley (*Grace*).

S. (O.) devonica, sp. n. ♂. Very similar to *O. minor*, but smaller (wing-length only 1·8 mm.); wings as in the last species with a deeper brown tinge (by transmitted light) at the tip; costa slightly produced, and lobe rather more obtuse; *An* fainter apically but reaching beyond *fCu*. A.R. only about 0·6, last segment rather conspicuously clubbed but with short pubescence extending some way back from tip as in the last two. Hypopygium (fig. 6*v*) almost as in the last species, style and basal lobe slightly different. Squama with about six rather widely spaced hairs. Gorge of Dart, S. Devon, 1 ♂ (*F.W.E.*).

Group E.

Wings brown by transmitted light; no microtrichia. Costa not produced. R_{2+3} ending before midway between R_1 and R_{4+5}. R_{4+5} ending above or just beyond level of tip of Cu_1; *r-m* almost continuing direction of *M*; *An* not reaching *fCu*, which is far beyond *r-m*. Cu_2 distinctly bent in middle. Lobe distinctly produced. A.R. more than 1. No pulvilli. Empodium longer than claws. Wing-length under 3 mm.

A single rather well-marked species is placed here. In most respects it resembles *Smittia*, but I exclude it from that subgenus on account of the fringed squama.

S. (O.) flexuella, sp. n. ♂. Body all black. Antennae with dark plumes, A.R. about 1·7; tip with fine pubescence extending back some distance. Thorax distinctly shining, except on the scutellum. Abdomen dull, with narrow shining bands at the joints. Hypopygium, (fig. 6*w*). Legs blackish, tibiae and tarsi lighter; hair on posterior tibiae and tarsi rather long; empodium longer than claws. Wings (Plate XVIII, fig. 6) with a rather strong brown tinge by transmitted light, outer half somewhat darker; all veins pale except stem-vein, which is blackish. Squama dark, with complete fringe. Halteres white, base of stem black. Wing-length 2 mm. Slapton, S. Devon, 7.ix.1888, 1 ♂ (*Verrall*); Pinner, Middlesex; Whernside, Yorks.; Snailbeach, Salop (*F.W.E.*).

Group F.

Wings brown or purplish by transmitted light; no microtrichia. Costa rather conspicuously produced. R_{2+3} ending much nearer to R_{4+5} than to R_1, sometimes only slightly separated from R_{4+5} at tip. R_{4+5} ending above or just beyond level of tip of Cu_1. *An*

ending close to *fCu*, which is beyond *r-m*. Cu_2 more or less bent in middle. Lobe rather obtuse. Empodia about as long as claws. Small narrow pulvilli present.

Two British species, which seem intermediate between Group D and the subgenus *Eukiefferiella*; at the same time the bent Cu_2 suggests a connection with *Smittia*, and the presence of small pulvilli with *Psectrocladius*, in which they were included by Kieffer and Goetghebuer.

S. (O.) curtistylus (Goet.). ♂. Antennae dark, with pale plumes, A.R. about 0·7; tip with about 5–8 rather long curly hairs. Thorax with yellowish ground-colour; scutal stripes, scutellum, postnotum and sternum blackish-brown, prescutellar area also somewhat darkened; surface slightly shining, with little trace of grey dusting. Abdomen brown. Hypopygium without anal point, ninth tergite small, triangular and bearing a few bristles; style with long terminal spine; basal lobe broad, not free. Legs brownish. Anal area rather small, obtusely rounded; squama with 2–3 small hairs. Halteres yellowish. Wing-length about 1·4 mm.

♀. Yellow, scutal stripes hardly indicated; only dorsum of abdomen brown, cerci and venter yellowish. Antennae 6-segmented, flagellum all dark; last segment oval, broader than the penultimate, but not as long as 4 and 5 together, hairs rather shorter, straighter and more numerous than in the ♂. Venation much as in ♂. Wicken, Cambs.; Radwell, Herts. (*F.W.E.*).

A variety (?) from Poynton, Cheshire (*Britten*) has the antennal plume dark; knob of halteres slightly darkened; wings decidedly less milky (faintly purplish-brown by transmitted light); squama with 3–5 hairs.

S. (O.) filiformis (Kieff.)? Much resembles *E. curtistylus*, but rather larger (wing nearly 2 mm.); ♂ almost all dull black, with dark halteres; ♀ with yellowish halteres, lateral scutal stripes usually black, median stripe reddish; A.R. 1·1; hypopygium differs slightly; pulvilli rather longer but still narrow. R_{4+5} straighter, costa less produced; cubital fork slightly longer, Cu_2 slightly less bent; squama with 6–8 hairs. Arran; L. Windermere; Sidmouth, S. Devon; Bramhope, Yorks. (*F.W.E.*).

Subgenus **Eukiefferiella,** Tnm. (emended).

Eyes bare or pubescent. Squama usually with an incomplete fringe of a few hairs only; in some species quite bare. Wings milky, without microtrichia or macrotrichia. Base of cubital fork well beyond *r-m*, which is oblique. *M* usually quite straight, not curved down beyond the cross-vein. Cu_1 straight and continuing the direction of *Cu*. Cu_2 usually straight, the fork rather wide. R_{2+3} appearing absent, owing to its lying in close contact with R_{4+5}; it gradually fades out towards the tip and does not distinctly reach the costa; R_{4+5} practically straight, tip slightly turned up towards costa, which ends well before wing-tip. Lobe more or less rounded, not produced. Empodium well developed; no tarsal spurs. Small species, wing 2·5 mm. or less; never entirely black.

The name *Eukiefferiella* was introduced by Thienemann (*Arch. Hydrobiol.* xvii, p. 325, 1926) to designate one of the groups of *Orthocladius* as defined in Potthast's paper on larvae (*Arch. Hydrobiol.*, Supp.-Bd. II, p. 238). No adult characters were mentioned, but *Dactylocladius longicalcar*, Kieff. (1911*b*), was indicated as the genotype, and *D. brevicalcar*, Kieff., mentioned as belonging to the genus. Unfortunately the diagnoses of both these species are totally inadequate for recognition, and the specimen kindly sent me by Thienemann as *D. longicalcar* (the only one he possessed) proved to have been wrongly named, as it did not correspond even with the few characters indicated by Kieffer. I

have, however, examined several specimens of *D. brevicalcar*, Kieff., and these must be taken as typical of the genus until fresh material of *D. longicalcar* is available (presumably it can be recognised from Potthast's description of the larva and pupa).

Goetghebuer's *Cricotopus albicornis* agrees with *S. brevicalcar* in venation, including the peculiar feature of R_{2+3} being completely in contact with R_{4+5}, and I therefore refer it also to this subgenus, in spite of some points of disagreement with the other species. Four or five other species have been found in Britain for which I have been unable to find names; I therefore describe them below as new.

The North American *Dactylocladius brevinervis*, Mall., evidently belongs to this subgenus, and may be identical with *S. brevicalcar*. Malloch had indicated the desirability of separating this species from *Dactylocladius* on the venational character which I have made use of.

1. Hind femora with basal half only dark; pulvilli present; eyes pubescent; *bicolor*, Zett.
   Hind femora uniformly coloured; no pulvilli . . . . . 2.
2. Squama fringed; A.R. at least 0·5 . . . . . 3.
   Squama quite bare; A.R. about 0·3–0·4 . . . . . 5.
3. Costa ending distinctly before tip of Cu_1; A.R. 0·9 . . . . *hospita*, sp. n.
   Costa ending above or scarcely before tip of Cu_1; A.R. 0·5–0·7 . . . . 6.
4. Hypopygium without anal point . . . . . *brevicalcar*, Kieff.
   Anal point present . . . . . *calvescens*, sp. n.
5. Eyes pubescent . . . . . *coerulescens*, Kieff.
   Eyes bare . . . . . 6.
6. Cu_2 almost straight . . . . . *coronata*, sp. n.
   Cu_2 distinctly bent . . . . . *camptophleps*, sp. n.

S. (E.) bicolor (Zett.) (*femorata*, Staeg.; *perexilis*, Walk.; *Orthocladius nanulus*, v.d.W.; *Cricotopus albicornis*, Goet.; *C. albipluma*, Kieff., 1924c). Eyes densely pubescent. Antennal plume of ♂ white, A.R. about 1·0. Antennae of ♀ yellow, last segment black, with long pubescence, especially towards tip. Thorax of ♂ almost all black; of ♀ light yellow, scutal stripes well separated, light brownish to black, postnotum and sternum black; whole surface quite dull in both sexes, but without grey dusting. Legs largely whitish, front femora and tibiae more or less darkened, middle and hind femora with a broad brownish or black ring at base. Small pulvilli present. Wings entirely white (veins and membrane). Squamal fringe reduced to 2–4 hairs. Hypopygium with short anal point; style apparently with two terminal spines placed close together, one dark and the other pale; some local variation in shape of basal lobe. Common.

Walker's type is immature and faded, but shows traces of dark rings on the posterior femora and there is no doubt it belongs to this species. Van der Wulp's statement that the thorax of his type was shining was probably an error, as his description otherwise agrees with our specimens.

The name *Chironomus bicolor* was proposed independently in the year 1838 by Meigen and Zetterstedt for two quite different species; I do not know which description was published first.

S. (E.) hospita, sp. n. Eyes bare. Antennal plume of ♂ dark. A.R. about 0·9; tip of antenna slender, with pubescence extending back some distance (fig. 8*a*). Antennae of ♀ dark, last segment pointed, longer than the two preceding, with numerous short hairs on outer two-thirds; segments

3–5 oval. Thorax of ♂ black, slightly shining, shoulders and pleural patch yellow; of ♀ with ground-colour yellow, scutal stripes, etc., blackish. Abdomen blackish in ♂, lighter in ♀. Hypopygium (fig. 7*b*) without anal point; style with one stout, dark terminal spine, coxite enlarged on ventral side except

Fig. 7.—♂. Hypopygium (right half, from above) of species of *Spaniotoma* and *Corynoneura*. a, *S.* (*Eukiefferiella*) *brevicalcar*, Kieff. b, *S.* (*E.*) *hospita*, sp. n. c, *S.* (*E.*) *calvescens*, sp. n. d, *S.* (*E.*) *camptophleps*, sp. n. e, *S.* (*E.*) *coerulescens*, Kieff. f, *S.* (*Smittia*) *ephemerae*, Kieff. g, *S.* (*S.*) *ornaticollis*, sp. n. h, *S.* (*S.*) *recta*, sp. n. i, *S* (*S.*) *trilobata*, sp. n. j, *S.* (*S.*) *curticosta*, sp. n. k, *S.* (*S.*) *cheethami*, sp. n. l, *S.* (*S.*) *angusta*, sp. n. m, *C. scutellata*, Winn., var. (?). n, *C.* (*Thienemanniella*) *flavescens*, sp. n.

at tip; dorsal basal lobe large. Legs light to dark brown, sometimes almost black in ♂, femora unicolorous. No pulvilli. Posterior tibiae with longish hair. Spurs of middle tibiae short. Outer spur of hind tibia scarcely distinguishable, inner rather long (as in other allied species). Wings (Plate XVIII,

fig. 7) milky; when viewed by transmitted light brownish, extreme tip darker brown. Costa conspicuously produced but ending distinctly before level of tip of Cu_1. R_1 (in ♂) less than half as long as R_{4+5}; *fCu* below middle of R_1; Cu_2 practically straight, only the extreme tip bent forward. Anal area rather large but obtuse. Squama with 6–8 small hairs. Halteres yellow. Wing-length about 2 mm. Common. Type from Radwell, Herts. I have found the larvae in association with *Simulium* pupae (see *Bull. Ent. Res.*, xi, p. 215, 1920). The pupa differs only in minor details from Potthast's description of *E. longicalcar*.

S. (E.) brevicalcar (Kieff.), 1911*b*. Very similar to *S. hospita*, but A.R. only about 0·7; scutal stripes of ♂ more or less separate; pleurae mainly pale; hypopygium (fig. 7*a*) differs slightly, style with a small, pale terminal spine; wings less milky, tip not appearing darkened by transmitted light; costa less produced, but extending slightly beyond level of tip of Cu_1, R_{4+5} longer.

Apparently common in hilly districts. Whernside and Austwick, Yorks.; Snailbeach and Church Stretton, Salop.; Dartmouth, S. Devon (*F.W.E.*); Newtown, N. Wales and Minchinhampton, Glos. (*Ricardo*); Goyt Valley, Cheshire (*Britten*).

British material appears to correspond closely with German specimens received from Thienemann and determined as *E. brevicalcar*, but it is possible that two species may be confused. During the summer of 1928 Dr. S. L. Hora obtained a number of pupae from rapid streams in the island of Arran, and from these I dissected adults which do not seem to differ from *S. brevicalcar* as described above. The pupae, however, are different from those of *S. brevicalcar* as described by Potthast, and are apparently identical with his "*Dactylocladius* 'Schildgespinst.'"

S. (E.) calvescens, sp. n. Resembles the last two in having bare eyes and squama distinctly fringed. A.R. 0·55–0·75 (usually about 0·65), the short apical pubescence confined to the tip (fig. 8*b*) and not extending so far back as in *S. hospita* and *S. brevicalcar*. Colour as in *S. brevicalcar*; typical ♂ specimens have the scutal stripes blackish and distinctly separated; pleurae and legs largely dark; a variety (?) has brownish scutal stripes, pleurae entirely yellow and legs pale. Hypopygium (fig. 7*c*) differing from the last two species in having a well-developed anal point, and no interno-ventral enlargement of the coxite; basal lobe quite differently shaped; style with a long stout terminal spine. Wings almost as in *S. brevicalcar*; costa slightly shorter, ending above tip of Cu_1; Cu_2 very slightly but perceptibly bent. Wing-length 1·8–2·2 mm.

Ilkley, Yorks. (*Grace*). Pale variety from Salisbury (*Miss Ricardo*); Colwich Park, Staffs. (*Verrall*); Snailbeach, Salop and Austwick, Yorks. (*F.W.E.*); Melkinthorpe, Westmorland (*Britten*).

A variety (?) from Hauxton, Cambs. (*F.W.E.*) is larger (wing-length 2·7 mm.); basal lobe of hypopygium rather differently shaped; anal point longer.

S. (E.) camptophleps, sp. n. ♂. Eyes bare. Antennal plume dark, A.R. only about 0·35, last segment rather distinctly clubbed and hardly longer than preceding three together, with short pubescence extending back some distance from tip (fig. 8*d*). Head dark above. Thorax with yellow ground-colour, scutal stripes dull blackish and well separated. Abdomen dark brown, tergites with hind margins lighter. Hypopygium (fig. 7*d*) with ninth tergite more chitinised than in the other species, but as usual without distinct anal point; style with long pale terminal spine; dorsal basal lobe rounded; coxite not enlarged ventrally on inner side. Legs pale. No pulvilli. Wings (Plate XVIII, fig. 8) faintly brownish by transmitted light, tip not distinctly darker.

Costa greatly produced, but ending just before level of tip of Cu_1. R_1 about two-fifths as long as R_{4+5}. Cu_2 rather strongly bent. Squama bare. Wing-length about 1·2 mm. Newtown, N. Wales, 11.ix.1893, 1 ♂ (*Miss Ricardo*); Staveley, Westmorland (*F.W.E.*).

♀. Entirely yellow, including mouth-parts and legs; only the terminal segment of antennae darker, this almost as long as the three preceding segments together and pubescent for two-thirds of its length. Venation as in ♂, except that costa is somewhat longer, extending slightly beyond level of tip of Cu_1. Staveley, Westmorland (*F.W.E.*).

In the strongly bent vein Cu_2 this species differs markedly from all other species included in this subgenus; in many respects it rather closely resembles *S.* (*Smittia*) *ephemerae*, Zavr.

S. (E.) coronata, sp. n. ♂. Similar to the last, but A.R. 0·4, and apical pubescence confined to extreme tip of antenna (fig. 8*c*), where it forms a small rosette as in certain species of *Corynoneura*; thorax entirely black; Cu_2 scarcely bent. Hypopygium almost as in *S. camptophleps*; styles perhaps a little shorter and stouter; lobe of coxite more square. Corrour, Inverness, vii.1914, type ♂ in Edinburgh Museum (*Grimshaw*); Llyn Gwynant, Carnarvon (*F.W.E.*).

S. (E.) coerulescens (Kieff., in Zavrel, 1926*a*). Eyes with fine and rather sparse but distinct pubescence. Antenna of ♂ with rather sparse, light-brownish plume; A.R. about 0·3, last segment clubbed, about equal in length to the three preceding, and with apical pubescence extending back a short distance from tip. Thorax of ♂ almost entirely black, of ♀ yellowish with separate brown scutal stripes. Abdomen blackish. Hypopygium (fig. 7*e*) similar to that of *S. hospita*; coxites enlarged beneath on inner face, but style with numerous short hairs on flexor surface. Legs brownish, darker in ♂; no pulvilli. Wings by transmitted light appearing brownish with darker brown tip. Costa only moderately produced, and ending far before level of tip of Cu_1. R_1 very short, hardly more than one-third as long as R_{4+5}. Cu_2 very slightly bent. Squama quite bare, as in the last two species. Anal area perhaps rather more obtuse than in the others. Wing-length about 1·3 mm.

Whernside and Austwick, Yorks.; Correin Lochan, Arran; Gorge of Dart, S. Devon (*F.W.E.*); Melkinthorpe, Westmorland (*Britten*). Cotypes of *Trichocladius coerulescens*, Kieff., received from Prof. Zavrel agree in all respects with British specimens.

Subgenus **Limnophyes,** Eaton.

Eyes bare. Squama with an incomplete fringe of from 2–6 hairs. Wings greyish-hyaline, in ♀ with fine microtrichia about 3 μ long, clearly visible under a magnification of 300; no macrotrichia; anal lobe very obtuse. Base of cubital fork much beyond *r-m*. R_{2+3} well separated from R_{4+5} and ending nearer to R_1. *M* much curved down beyond *r-m*. Cu_2 moderately bent in middle, fork wide. *An* straight and ending opposite *fCu*. Costa moderately produced. Tibiae and tarsi without long hairs. Pulvilli absent; empodium as long as claws or nearly. Small, usually black species, wing-length 1·5–2 mm.

The genus *Limnophyes* was introduced by Eaton for a species from Kerguelen Island, Antarctic Ocean. I have examined the types (6 ♀♀ in the British Museum) and am unable to separate them from *Camptocladius exiguus*, Goet. (*hexatomus*, Kieff.); it is probable that the species was introduced to Kerguelen from Europe. *C. exiguus* was treated by Thienemann (1921) as the type of *Camptocladius*, but wrongly, since it was not originally included in the

genus and Coquillett had previously designated *C. byssinus*. Thienemann has, however, shown that there are considerable differences in the early stages between this group and *Camptocladius* (*Phaenocladius*), and these differences are supported by others in the adults, especially the presence of microtrichia on the wings and a few hairs on the squama. I therefore treat the group as subgenerically distinct.

The species are mostly extremely similar. All have the thorax somewhat shining; A.R. never more than 1; except in *S. hydrophila* the hairs at the extreme tip of the ♂ antenna are longish, not short as they are in *Smittia*, and there is no bare area before the tip. The last few segments of the ♂ antenna are not very well separated, and there are sometimes only 13 or even only 12 distinct segments instead of the usual 14.

1. Hypopygium with short anal point; last segment of antennae in ♀ without verticil, in ♂ with short pubescence at tip . . . . . *hydrophila*, Goet.
   Hypopygium without anal point; last segment of antennae in ♀ with verticil at base, in ♂ with long pubescence at tip (fig. 8*h*) . . . . . 2.
2. Scutum without scales on prescutellar area; tip of ♂ style not prolonged . 3.
   Scutum with small suberect scales on prescutellar area between dorsocentral hairs; tip of male style prolonged and blackened . . . . . 6.
3. Squama with two (rarely three) hairs . . . . . 4.
   Squama with 4–5 hairs . . . . . 5.
4. Halteres yellow . . . . . *pusilla*, Eat.
   Halteres with blackish knob . . . . . *minima*, Mg.
5. A.R. about 0·8; wings grey; no scales . . . . . *habilis*, Walk.
   A.R. about 0·6; wings white; small scales on shoulders . *pumilio*, Holmgr.
6. Scutal scales few in number, none on shoulders; A.R. about 0·75 *truncorum*, Goet.
   Scutal scales more numerous, present also on shoulders . . . . . 7.
7. A.R. about 0·6 . . . . . *prolongata*, Kieff.
   A.R. about 0·25–0·3 . . . . . *gurgicola*, sp. n.

S. (L.) hydrophila (Goet.) (*longiseta*, Thienemann, Kieff.; ? *foenisuga*, Kieff., ♂, 1921*c*). Entirely black in both sexes; thorax without grey dusting even when viewed from in front. A.R. about 0·8, tip of last segment pointed, with shorter pubescence than the other species; last segment of ♀ antenna without verticil. No humeral pits; dorsocentral hairs dark, biserial; no scales on scutum. Hypopygium with short but distinct anal point; style with stout, blunt terminal spine. Wings much as in the other species; squama with 3–4 hairs. Harrow Weald, Middlesex; Burnham Beeches, Bucks.; Knebworth, Herts.; Stickle Tarn, Westmorland (*F.W.E.*).

S. (L.) pusilla, Eat. (*exiguus*, Goet., 1913*a*; *hexatomus*, Kieff., 1915*d* and 1921*c*). Differs from all the other British species in having the halteres yellow in both sexes; scutum black in ♂, yellow with brown or blackish stripes in ♀; rather distinct grey dusting on most of scutum, especially on prescutellar area when seen from in front. A.R. about 0·8, tip of last segment blunt, with long pubescence; last segment of ♀ antennae with long basal verticil. Humeral pits present, but small; dorsocentral hairs pale, uniserial, no scales on scutum. Hypopygium without anal point; style not much enlarged on inner side, terminal spine rather long and pointed, tip not produced. Wings grey. Squama with two hairs only. Very common everywhere.

S. (L.) minima (Mg.) (*punctulatus*, Goet., 1913*a*). Very similar to *S. pusilla*, especially in structure of hypopygium and in having only two hairs on the

squama; differs in having the thorax and knob of halteres black in both sexes. Dorsocentral hairs dark. A.R. about 0·6, penultimate segment twice as long as broad. Very common.

S. (L.) habilis (Walk.). Rather larger than the last two (wing-length about 2·2 mm. instead of 1·8–2 mm.), and also differs from *S. minima* as follows:— A.R. about 0·85, penultimate segment hardly 1·5 times as long as broad. Humeral pits rather larger, appearing distinctly margined with grey dust when viewed from in front. Dorsocentral hairs irregularly biserial. Basal lobe of ♂ coxite less pointed. Squama with 4–5 hairs. Wicken, Cambs.; Audley End, Essex (*F.W.E.*). Walker's type ♀ agrees well with the other specimens.

S. (L.) pumilio (Holmgr.). Black, with black halteres and dark legs. Scutum shining, with scarcely any grey dusting; no scales on prescutellar area (?) but a number on shoulders, these smaller and narrower than those of *S. prolongata* and difficult to detect. Dorsocentral hairs shorter than usual, pale and uniserial. A.R. 0·5–0·7; antennae of ♀ 7-segmented, 2–5 hardly longer than broad, with long verticils and very short sense-bristles, 6 and 7 each a little under twice as long as broad, the division between them indistinct, 6 with rather long basal, 7 with short median verticil. Hypopygium very much as in *S. minima*, but basal lobe bare on the distal edge instead of fringed all round; style differently shaped at tip, and its terminal spine more pointed, ninth tergite with a slight triangular projection in middle. Fourth segment of middle tarsi only 1·5 times as long as broad and much shorter than fifth, that of hind tarsi not quite so short. Empodium as long as claws. Wings conspicuously white in both sexes by reflected light, though quite colourless by transmitted light; in shape rather broader than in *S. minima*, lobe in ♂ almost right-angled. Venation as in *S. minima*, but costa rather less produced. Squama with 4–6 hairs. Wing-length 1·7–2 mm.

Catacol, Arran (*F.W.E.*); Kinlochewe, Ross (*W. R. O. Grant*); Bonhill, Dumbarton (*Malloch*). Specimens in the British Museum from Spitsbergen and Norway determined by me as *S. pumilio*, agree with Scottish examples except that the basal lobe of the hypopygium is rather smaller and more finger-like; they have similar minute scales on the shoulders.

S. (L.) prolongata (Kieff., in Tnm., 1921) (*pentaplastus*, Kieff., ♂, 1921*c*; *punctatellus*, Goet., 1923*a*; *clavaticornis*, Goet., 1927*b*). Black, with black halteres and slight grey dusting on thorax. A.R. about 0·5–0·6. Scutum with a double row of suberect scales on each side of the prescutellar area, between the dorsocentral hairs, also a patch of similar scales on the shoulders, in the region of the very small humeral pits; these scales (or modified hairs) are slender at the base and tip, broad in the middle, and about one-third as long as the dorsocentral hairs, these latter pale and biserial. Male styles much enlarged on inner face before middle, distal third narrow and blackened; no articulated spine, but two long bristles placed at base of slender portion. Extreme base of wing, as far as the alula, conspicuously white. Squama with 4–6 hairs. Rather common.

According to Kieffer the ♀ of *C. pentaplastus* (1921*c*) has only 5 antennal segments, the sixth being fused with the fifth, and 3 and 4 short and rounded. Goetghebuer, however, figures the ♀ antenna as having 6-segments, 3–5 being rather elongate oval, as in *S. minima* and related species. Males from Britain agree with specimens received from Thienemann as *Camptocladius pentaplastus* var. *prolongatus*, females with Goetghebuer's description and figure. I believe therefore that the female described by Kieffer belongs to another species for which the name *pentaplastus* should perhaps be used; our species must be known

as *S. prolongata*, Kieffer's varietal name (see Thienemann, 1921) having precedence. A specimen of *C. clavaticornis* received from Dr. Goetghebuer proves that this name is another synonym.

S. (L.) truncorum (Goet.). Resembles the last in colour. A.R. about 0·75. Scutum with a single row of scales on each side of the prescutellar area, none on shoulders; scales shorter than in *S. prolongata* and difficult to detect except in a very good light. Humeral pits rather large and bordered with grey. Dorsocentral hairs uniserial and dark. Male style somewhat as in *S. prolongata*, but with a long and rather strong articulated spine some distance before tip. Squama with 4–6 hairs. Harlesden, Middlesex (*Austen*); Crowborough, Sussex (*Jenkinson*); Mildenhall, Suffolk and Shelford, Cambs. (*F.W.E.*).

A variety (?) has the terminal spine of the ♂ style very slender, bristle-like, inserted close to the tip. Antennae of ♀ similar to those of *S. minima*. Letchworth, Herts. (*F.W.E.*); Beeston, Notts. (*Carr*).

S. (L.) gurgicola, sp. n. Closely resembles *S. prolongata*, differing as follows: —A.R. only 0·25–0·3, plume rather scanty; penultimate segment over twice as long as broad. Bristles and scales of scutum all black. Squama with 2–3 hairs only. Hypopygium almost as in *S. prolongata*, but slender terminal portion of style relatively shorter. Wing of ♂ (Plate XVIII, fig. 9). Wing-length about 1·5 mm. Staveley, Westmorland, vi.1929, 7 ♂♂ 1 ♀; Whernside, Yorks., 1 ♂ (*F.W.E.*).

Subgenus **Smittia,** Holmgren.

(*Camptocladius*, v.d.W.; *Phaenocladius*, Kieff.)

Eyes bare or very shortly pubescent, the hairs when present shorter than the diameter of one facet. Pulvilli usually absent, rarely present but small. Wings more or less milky by reflected light, at least slightly tinged with brown or purplish by transmitted light. R_{2+3} at least slightly separated from R_{4+5} and ending in costa; *fCu* considerably beyond *r-m*; Cu_2 usually sharply curved or bent in middle, rarely quite straight. Squama always quite bare. Small, usually black species, with a maximum wing-length of 2·5 mm.

The genus *Smittia* was founded by Holmgren for two species occurring in Spitsbergen, with abbreviated wings in one or both sexes. Having examined the types I am of the opinion that *S. longipennis* should be included in *Metriocnemus*,* and that *S. brevipennis* (the genotype) is a *Camptocladius*. The mere reduction of the wings, in the absence of other important structural differences, is not a sufficient generic character. As the name *Smittia* was published five years earlier than *Camptocladius* it must now replace the latter. This is hardly a disadvantage, in view of the present re-definition of the group and of the fact that numerous species have been referred to *Camptocladius* which do not rightly belong there. In a recent paper (1924*a*) I stated that *S. brevipennis* had bare eyes and was "probably of the *minimus* group" (*i.e.* subgenus *Limnophyes*). This I now find was an error; a mounted specimen shows that the eyes are very distinctly pubescent; the squama is absolutely bare, and the species belongs certainly to the *aterrimus* group.

Camptocladius was introduced by van der Wulp for three species: *stercorarius*, De G. (as *byssinus*, Schr.), *aterrimus*, Mg., and *minimus*, Mg. The first of these was designated as the genotype by Coquillett; the second belongs to a group for which Kieffer has proposed the name *Phaenocladius*; the third has all the characters of *Limnophyes*, Eaton (discussed above), and represents *Campto-*

* *Dolichoprymna*, Lundstr., proposed for *S. longipennis*, therefore becomes a synonym of *Metriocnemus*. *Arctomyia sibirica*, Lundstr., is also a *Metriocnemus* with short wings.

cladius as understood by Thienemann in 1921. *Camptocladius* and *Phaenocladius* have so much in common that their separation hardly seems justified; *Limnophyes*, on the other hand, differs in several respects and is treated here as a distinct subgenus.

The single character on which *Camptocladius* was founded was the bent or wavy vein Cu_2. This is well shown in most of the species, but the condition varies, and moreover, some species of other subgenera show rather a similar condition, so that in this respect it is difficult to define the subgenus accurately. I find that all the white-winged species have a completely bare squama, and this in conjunction with the shortened cubital fork should aid in the recognition of the subgenus. Only a few other Orthocladiinae are known to me in which the squama has not at least two or three hairs: two or three in the genus *Metriocnemus*, a few in Group B of the subgenus *Orthocladius* and in the subgenus *Eukiefferiella*, also *Diplocladius cultriger* and all the species of *Corynoneura*.

Phaenocladius was distinguished by Kieffer on account of the pubescent eyes, the species having been at first referred by him to *Trichocladius*, but this, character is not of much importance and varies in closely allied species.

The species of this subgenus are very numerous and exhibit considerable structural diversity. Some are rather arbitrarily placed here on account of the bare squama and agreement in most other respects with the diagnosis given above; it is possible that some of these should be removed to other subgenera. Five rather distinct groups may be recognised among the British species.

Key to Groups of Subgenus *Smittia*.

1. *An* reaching beyond *fCu* . . . . . 2.
   An not reaching beyond *fCu* . . . . . 4.
2. *An* straight; thorax largely yellow . . . . . *Group A.*
   An curved down at tip; body all black . . . . . 3.
3. Pulvilli absent, *An* not reaching margin . . . . . *Group B.*
   Pulvilli present, *An* normally reaching margin . . . . . *Group C.*
4. *An* ending about opposite *fCu*; R_{4+5} ending near level of tip of Cu_1 *Group D.*
   An usually ending before *fCu*; R_{4+5} ending before level of tip of Cu_1 . *Group E.*

Group A.

(*Epoicocladius*, Zavrel, 1924.)

Eyes bare. Pulvilli absent or indistinct. Costa distinctly produced; *r-m* oblique; Cu_2 distinctly bent in middle. *An* almost straight, reaching well beyond *fCu*. Anal lobe well developed but rather obtuse. Thorax with yellow ground-colour.

Three British species.

S. (S.) ephemerae (Kieff., in Zavrel, 1924). Almost entirely yellow; scutal stripes in ♂ only slightly darker, posterior half of postnotum and a dot at posterior end of lateral scutal stripes brownish; thorax of ♀ all yellow. R_{2+3} ending near R_1 in ♀, rather more distally in ♂; R_{4+5} ending above or scarcely before level of tip of Cu_1. A.R. about 0·9. Hypopygium (fig. 7*f*). Leeds (*Glover*); Poynton, Cheshire (*Britten*).

I am indebted to Dr. Zavrel for a female cotype of this species, the wing of which is shown in Plate XVIII, fig. 12. British specimens agree well with this type (♂ wing, Plate XVIII, fig. 11). *S. ephemerae* is chiefly interesting on account of the epizoic habits of the larvae, which live in association with nymphs of *Ephemera*.

S. (S.) cheethami, sp. n. ♂. *Head* blackish, antennae and palpi brown, plumes dark. A.R. about 0·8, last segment somewhat clubbed, tip with at least a dozen longish and somewhat curled hairs. *Thorax* slightly shining, with brownish-yellow ground-colour; scutal stripes blackish, fused or narrowly separate; postnotum and sternum black. *Abdomen* brownish. Hypopygium (fig. 7*k*) with large, prominent, broadly triangular anal point; style curved, broadest near tip; basal lobe large and prominent. *Legs* slender, brownish. Femora and tibiae with rather short hairs. Last two tarsal segments subequal. *Wings* (Plate XVIII, fig. 10) strongly milky, pale brown by transmitted light; all veins white; R_{2+3} ending only slightly before tip of R_{4+5}, which is distinctly before level of tip of Cu_1; *An* continued faintly for some distance beyond *fCu*. Halteres brownish-yellow. Wing-length about 1·3 mm.

♀. Resembles ♂, but ground-colour of thorax clearer yellow; scutal stripes reddish-brown and more widely separated; scutellum yellow. Abdomen mainly dark above, cerci yellowish.

Lake Windermere, 9.vii.1923, type ♂; vi.1929, 1 ♂ (*F.W.E.*); Bolton Abbey, Yorks., 1 ♂ (*F.W.E.* and *C. A. Cheetham*); Hitchin, Herts., 1 ♀ (*F.W.E.*).

Although this has much in common with the last species, it might almost equally well be placed in Group F of the subgenus *Orthocladius*, near *S. curtistylus*, Goet.

S. (S.) ornaticollis, sp. n. ♂. *Head* blackish above, with some golden-yellow hair. Face yellow, palpi dark brown. Antennae with shaft and plume brownish; A.R. about 0·9; last segment apically with about 7–10 short, straight hairs, all very close to tip. *Thorax* with pronotum and pleural membrane yellowish. Mesonotum with yellowish ground-colour, obscured by heavy grey pruinescence; scutal stripes black, heavily pruinose in some aspects; as seen from above the middle stripe appears almost silvery, the lateral stripes black and very slightly shining; from other points of view the black colour of the middle stripe is obvious, and the lateral stripes appear more or less silvered. Scutellum and postnotum black, somewhat shining. Sternum black, pruinose. Dorsocentral hairs yellow; a patch of small yellowish hairs on sternopleura. Pleural membrane yellowish. *Abdomen* rather light brownish. Hypopygium (fig. 7*g*) without anal point; ninth tergite large and pubescent; basal lobe very large; style with large, stout terminal spine enclosed in a remarkable sheathing base. *Legs* as in the last species. *Wings* with scarcely any milky tinge, faintly purplish by transmitted light; anterior veins pale brownish. R_{2+3} ending just beyond midway between R_1 and R_{4+5}; costa moderately produced; R_{4+5} ending above tip of Cu_1; *fCu* only slightly beyond *r-m*; *An* reaching a short distance beyond *fCu*. Lobe very obtuse. Halteres yellowish. Wing-length about 1·5 mm.

♀. Resembles ♂ in the peculiar pruinescence of the scutum. Antennae rather long, yellowish, including basal segment; 2 over twice as long as wide and scarcely constricted; 3–5 about twice as long as wide, with long sense-bristles near tip, 6 about as long as 4 and 5 together. Scutellum yellow. Costa rather more produced than in ♂; cubital fork rather longer, *fCu* directly below *r-m*; Cu_2 slightly less bent than in ♂.

Nelson, Lancs., 6.ix.1925, type ♂ (*Britten*); Fatfield, Durham, 14.viii.1916, 2 ♂♂ 1 ♀ (*Bagnall*); Killarney, v.1929, 1 ♀ (*F.W.E.*).

Group B.

(*Smittia*, s. str.; *Phoenocladius*, Kieff., in Tnm., 1921.)

Eyes pubescent or bare. Hair on posterior tibiae and tarsi in ♂ often very long. No pulvilli. Costa produced well beyond tip of R_{4+5} in both sexes, and usually beyond level of tip of Cu_1; *An* somewhat curved down at tip and reaching distinctly beyond *fCu*; *r-m* usually almost horizontal or moderately oblique, and R_{4+5} slightly sinuous, meeting costa at a low angle.

We have at least ten British species, but most of them are very similar and difficult to separate satisfactorily. All have the thorax and abdomen entirely black in the ♂ and usually also in the ♀.

1. Eyes finely and densely pubescent; lobe of wing right-angled . . . . 2.
   Eyes bare or nearly so . . . . . 5.
2. Squama and plume of ♂ antenna dark . . . . . 3.
   Squama, wing-base and antennal plume white . . . . . *leucopogon*, Mg.
3. Halteres of ♀ yellowish or brown . . . . . 4.
   Halteres of ♀ black, antennae shorter . . . . . sp. inc.
4. Male style with large subapical expansion . . . . . *aterrima*, Mg.
   Male style without subapical expansion . . . . . *contingens*, Walk.
5. Halteres blackish (♂♀) . . . . . 6.
   Halteres white . . . . . *thalassophila*, Goet.
6. R_{4+5} ending above or slightly beyond tip of Cu_1; lobe obtuse . . . . 7.
   R_{4+5} ending before level of tip of Cu_1 . . . . . 8.
7. Hypopygium with large basal lobe . . . . . *pratorum*, Goet.
   Hypopygium without distinct basal lobe . . . . . sp. inc.
8. Larger; A.R. 2·5; lobe of wing right-angled . . . . . *foliacea*, Kieff.
   Small; A.R. 1·5 or less; lobe obtuse or absent . . . . . 9.
9. Wings of ♂ strongly milky, lobe obtuse . . . . . sp. inc.
   Wings of ♂ scarcely milky, lobe absent . . . . . *nudipennis*, Goet.

S. (S.) aterrima (Mg.) (? *opacus*, Mg.; *nigratus*, Walk.; ? *sinuosus*, Kieff.; 1911*b*; ? *foliatus*, Kieff., 1906*b* and 1921*c*; *aquaticus*, Kieff., Goet.). Entirely dull black; legs and plume of antennae dark; halteres in ♂ dark to light brown, or even occasionally yellow, in ♀ usually if not always yellow. A.R. about 1·5–2; antennae of ♀ with 6 quite half as long again as 5; sense-bristles thick, almost leaf-like, but pointed, tips almost acuminate. Eyes densely pubescent. Hypopygium with rather short anal point, style with large expansion on inner side before tip. Wings milky, especially in ♂; R_{4+5} somewhat sinuous and ending above or just beyond level of tip of Cu_1; lobe rather well developed, right-angled; squama dark. Very common.

This is the species commonly determined as *C. aterrimus*, Mg.; I have accepted this name because there is nothing in Meigen's diagnosis to disagree with the usual interpretation; large specimens almost if not quite attain the dimensions given by Meigen (3 mm. body-length). Goetghebuer states that the type is a specimen of *Trichocladius lucidus* (*funebris*); I consider this specimen must have been wrongly named, as Meigen would not have described its thorax as "sammetschwarz." Another specimen labelled *aterrimus* in the Paris Museum is a *Metriocnemus*, and therefore also wrongly named. Meigen's *C. opacus* is probably the same species. Meigen and Goetghebuer describe the halteres as white; in our specimens they are usually dark brown in the ♂. I have, however, seen one or two ♂♂ with yellow halteres which in the hypopygium and other characters are not distinguishable from *C. aquaticus*, Goet.

S. (S.) contingens (Walk.) (? *aquatilis*, Goet.). Rather closely resembles *S. aterrima*, differing chiefly in the hypopygium: anal point longer and more slender; style with only a slight membranous expansion on inner side, and even this placed further from the tip than in *S. aterrima*; terminal spine longer (in the type it appears to be double, as in *C. aquatilis*, Goet., but in another ♂ I cannot detect this); basal lobe with less prominent lobule at the angle. Size rather smaller than the average *S. aterrima*; wing-length barely 2 mm. Halteres blackish. Apart from Walker's type I have only identified this species from Harrow, Middlesex (*F.W.E.*), but it is probably common.

S. (S.) sp. inc. ♀. Entirely black, including halteres. Antennae with segments 3–5 more rounded than in *S. aterrima*, 6 hardly longer than 5. Eyes pubescent. *An* somewhat shorter. Numerous ♀♀ but no ♂♂ were reared from larvae attacking rhizoids of exotic liverworts grown in a greenhouse at Lewes, xii.1913 (*W. E. Nicholson*). This is possibly the ♀ of *S. contingens*.

S. (S.) leucopogon (Mg.). Resembles *S. aterrima* in being dull black, with pubescent eyes, and halteres brownish to white in ♂, whitish in ♀, but differs in having the antennal plume white, A.R about 1·3; legs mostly pale, tibiae and tarsi sometimes almost whitish. Hypopygium with slight basal lobe, style more slender than in *S. aterrima*. Wings milky-white in both sexes, base of wing, including squama, pure white. Venation as in *S. aterrima*, except that *An* is rather shorter; lobe almost right-angled. Arran; Snailbeach and Church Stretton, Salop; Gormire, Yorks. (*F.W.E.*); Felden, Herts. (*Piffard*); Hitch Wood, Herts., reared from leaf mould (*F.W.E.*).

S. (S.) pratorum (Goet., 1927*c*). Dull black, including halteres in both sexes. Eyes bare. A.R. about 1·5. Sense-bristles of ♀ antennae short, slender and bristly, segments rather longer than in *S. aterrima*. Basal lobe of ♂ hypopygium more prominent than in *S. aterrima*, and anal point longer. Wings rather whiter in both sexes than in *S. aterrima*, but squama dark; *An* shorter, though distinctly curved down at tip; lobe obtuse. Common. Mr. H. Britten has sent me specimens (♀ only) reared from narcissus bulbs at Withington, Manchester, vi.1927.

S. (S.) sp. inc. Similar to *S. pratorum*, but hypopygium without distinct basal lobe, style with pointed projection at tip, and wings less milky; purplish in both sexes by transmitted light. Top of Goat Fell, Arran (*F.W.E.*).

S. (S.) foliacea (Kieff., 1921*c*, p. 789). Black, including halteres and legs in both sexes. Eyes almost bare, or with very short fine pubescence on the lower half only. A.R. quite 2·5, all the basal segments being broader than long. Sense-bristles of ♀ antennae small, almost equilaterally triangular; segments 3–5 rather short, 6 as long as 4 and 5 together. Hypopygium differs slightly from *S. aterrima*; wings of ♂ less milky, and R_{4+5} ends a little before instead of a little beyond level of tip of Cu_1. Lobe right-angled. Probably common. Letchworth, Herts., and Hauxton, Cambs. (*F.W.E.*); Cambridge (*Jenkinson*); Brothers' Water, Westmorland (*F.W.E.*).

S. (S.) sp. inc. Dull black, including legs and halteres in both sexes. Eyes almost or quite bare in ♂, with very short and rather scanty pubescence in ♀. A.R. about 1·4–1·6; sense-bristles of ♀ antennae short and rather broad. Hypopygium almost as in *S. aterrima*, but anal point longer and inner expansion of style less developed. Wings strongly milky, tip deeper brown by transmitted light; lobe obtuse. R_{4+5} straight and ending well before level of tip of Cu_1. Costa only moderately produced in ♂, more so in ♀. Cu_2 strongly bent and *An* curved down at tip as usual. Wing-length 1·5 mm. Correin Lochan, Arran (*F.W.E.*); Cambridge (*Jenkinson*).

S. (S.) nudipennis (Goet., 1913*a*). Differs from all the preceding in the reduction of the anal lobe of the wing, which is only very slightly indicated. Black, including legs and halteres in both sexes; thorax more or less shining. Eyes with very short pubescence, less distinct than in *S. aterrima*, and hypopygium differs slightly. A.R. scarcely more than 1. Wings scarcely milky, purplish by transmitted light. Costa strongly produced; R_{4+5} ending much before level of tip of Cu_1, but slightly sinuous as usual; *An* almost straight and reaching only a short distance beyond *fCu*. Wing-length 1·5–1·8 mm. Arran (*F.W.E.*).

S. (S.) thalassophila (Goet., 1913*b*). ♂. Dull black, legs pale ochreous, halteres almost white. Eyes bare. A.R. only about 0·7. Venation almost as in *S. aterrima*; lobe rather large but obtuse. Hypopygium with broad anal point, rounded at tip, and two separate lobes to coxite. ♀. Ground-colour of head and thorax yellowish, scutal stripes separate, brownish to black. Antennae with segment 6 almost as long as 3–5 together. Common on coasts between tide-marks.

Group C.

(*Camptocladius*, v.d.W.)

Eyes bare. Pulvilli present and rather distinct. Costa not or scarcely produced beyond tip of R_{4+5} in ♂, more distinctly so in ♀. Cu_2 strongly bent. *An* curved down at tip and almost or quite reaching margin of wing (a unique feature in this subfamily) Anal lobe well developed. Body all black in both sexes.

Only one British species.

S. (S.) stercoraria (De G.) (*byssinus*, Schrank; *Psectrocladius foliaceus*, Kieff., 1921*c*, p. 797). Black, including halteres, legs, squamae and stem vein; wings very milky. Male antennae with plumes mostly white, hairs nearest head black; A.R. usually about 1·3. Female antennae with broad leaf-like sense-bristles. Hypopygium with one projection on a large basal lobe. Abundant everywhere.

A small ♂ from Cambridge (*Jenkinson*) has A.R. only 0·9, plume entirely white, *An* not reaching margin, but hypopygium typical.

Group D.

Eyes bare. Pulvilli absent. Costa scarcely produced beyond tip of R_{4+5} in ♂, sometimes more so in ♀. Tip of R_{4+5} above or scarcely before level of tip of Cu_1. Cu_2 strongly bent. *An* practically straight and ending about opposite *fCu*. Lobe well-developed. Body black, at least in ♂.

I am acquainted with three British species, which have much resemblance to *S. stercoraria*.

S. (S.) gracilis (Goet., 1913*a*). Body black (scutum rather shining), but legs pale and halteres whitish; antennal plume also whitish (Goetghebuer described it as dark, but he informs me that this was an error). A.R. not more than 0·3. Hypopygium without conspicuous basal lobe; style somewhat square-ended. R_{2+3} ending near R_{4+5}, tip of which is before level of tip of Cu_1. Anal lobe of wing obtusely rounded. Newtown, N. Wales (*Miss Ricardo*); Addingham, Yorks. (*F.W.E.*).

S. (S.) recta, sp. n. ♂. Antennae 13-segmented, blackish, including plumes. A.R. about 0·6; last segment (fig. 8*i*) rather strongly clubbed; penultimate

segment over twice as long as broad. *Thorax* black, somewhat dusted with grey except on the scutal stripes, which are rather shining; pronotum fairly well developed as usual. *Abdomen* dark brown; hypopygium (fig. 7*h*) much as in *S. gracilis*, Goet., but lobe a little more obvious. *Legs* blackish; tibiae with long hairs as in the species of Group B; fourth and fifth tarsal segments subequal, over twice as long as broad; empodia as long as claws. *Wings* (Plate XVIII, fig. 13) rather milky; lobe large, about right-angled. R_1 and R_{4+5} bare. Venation as shown; no transverse fold beyond tip of *An.* Halteres dark brownish. Wing-length 2 mm.

♀. Resembles ♂ in colour, and also in having the costa ending rather abruptly at tip of R_{4+5}. Antennae not very short; segment 2 constricted in middle; 3–5 oval, slightly constricted apically and almost twice as long as broad, with short and rather broad sense-bristles, 6 about twice as long as 5, pubescent all over. Wings distinctly brown by transmitted light as in ♂.

Crowborough, Sussex, 9.iv.1906, type ♂ (*Jenkinson*). Staveley, Westmorland, 3 ♂♂ 1 ♀; Putney, S.-W. London, 1 ♂; Windermere, vi.1929, 1 ♂ (*F.W.E.*). Evidently related to *C. gracilis*, Goet., differing in its dark halteres, shape of wing, and rather longer terminal segment of antennae.

S. (S.) scotica, sp. n. ♀. Dull black, including legs and halteres. Antennae short, segments 3–5 not longer than broad, without necks, 6 twice as long as 5; sense-bristles short, triangular, none on segment 6. Fourth tarsal segment nearly globular, shorter than the fifth, which is oval. Wings strongly milky, uniformly brown by transmitted light. Costa moderately produced; R_{4+5} ending just before level of tip of Cu_1, but gradually fusing with costa; R_1 short, hardly more than one-third as long as R_{4+5}; Cu_2 strongly bent as usual and reaching the margin; *An* straight and just reaching *fCu*; lobe fairly well developed but obtuse. Wing-length barely 1 mm. Corriegills, Arran, 1 ♀ (*F.W.E.*).

Group E.

Eyes bare. Pulvilli absent or very small. Costa usually not produced. R_{4+5} ending before (often much before) level of tip of Cu_1. Cu_2 sometimes almost straight, in other species more or less bent. *An* ending before *fCu*, at least in ♂. Anal lobe of wing very obtuse or absent. Body all black, at least in ♂.

I am acquainted with six British species, four of which are described below as new. They show a good deal of structural diversity, and it is doubtful whether some of them are correctly placed in this subgenus.

1. Halteres whitish; R_1 and R_{4+5} fused; Cu_2 not nearly reaching wing-margin . . . . . *conjuncta*, sp. n.
   Halteres black, at least in ♂; R_1 and R_{4+5} not fused; Cu_2 almost or quite reaching wing-margin . . . . . 2.
2. Cu_2 distinctly bent as usual . . . . . 3.
   Cu_2 quite straight . . . . . 5.
3. Wings with anal area obtuse, but fairly well developed . . *trilobata*, sp. n.
   Wings cuneiform, without anal angle . . . . . 4.
4. Pronotum normal, visible dorsally; hypopygium without basal lobes . . . . . *curticosta*, sp. n.
   Pronotum reduced, not visible dorsally; hypopygium with three lobes on coxite . . . . . *angusta*, sp. n.
5. Costa not or scarcely produced . . . . . *brevifurcata*, Edw.
   Costa rather strongly produced . . . . . *albipennis*, Goet.

S. (S.) trilobata, sp. n. ♂. Body, legs and halteres dull black, but pleural membrane (at least in type ♂) obscurely yellowish, and some trace of yellow distinguishable on shoulders. Antennae with black plumes, A.R. quite 1·5; apparently only 13 segments present; fine hairs at tip (fig. 8*k*) straight, suberect, as long as diameter of segment and extending back from the tip for about twice this distance. Pronotum smaller than usual but just visible from above. Hypopygium (fig. 7*i*) remarkable in having three conspicuous lobes on coxite, projecting inwards. *Legs* with rather long hair, especially on posterior tibiae. No pulvilli. Last two tarsal segments about equal in length, fourth quite twice as long as broad. *Wings* (Plate XVIII, fig. 16) milky-white, squama and stem vein dark but not black. Venation as shown. Beyond tip of *An* is a rather distinct fold running almost parallel with the bent-down portion of Cu_2. Lobe obtusely rounded. Wing-length 1·3 mm.

♀. Antennae entirely blackish, 6-segmented, 3–5 shortly oval, with slender sense-bristles which are about as long as the segments; 6 rather longer than 4 and 5 together, almost uniformly covered with short hairs. *Thorax* with yellow ground-colour; scutum with three dull black stripes which are just separate; scutellum yellow, but a pair of black spots lie adjacent to it on the scutum, in contact with but internal to the lateral stripes. Postnotum and sternum black. *Abdomen* blackish above, hind margins of tergites paler; venter light brownish, cerci darker brown. *Legs* with femora blackish, tibiae and tarsi lighter. Pulvilli distinguishable though very small. *Wings* differing from those of ♂ (as usual) in being broader and having the costa longer, extending to level of tip of Cu_1 and reaching a little beyond R_{4+5}, this latter vein thickened and practically fused with the costa; R_{2+3} not distinguishable. *Cu* and *An* as in ♂, and as in that sex there is a fold beyond tip of *An* running nearly (but not quite) parallel with the second half of Cu_2. Halteres whitish.

Wicken, Cambs., 2.vii.1915, 3♂♂ 2♀♀ (including type ♂); Letchworth, Herts.; Corriegills, Arran; Sandy, Beds. (*F.W.E.*). In spite of the considerable differences between the two sexes I believe they are correctly associated. A peculiar feature is the transverse fold beyond the anal vein; this is found only in a few species (e.g. *S. brevifurcata*, Edw.).

S. (S.) curticosta, sp. n. ♂. Dull black, including halteres; legs rather light brownish (perhaps darker in fully mature specimens). Antennae with black plumes, A.R. 0·9–1; pubescence at tip normal. Pronotum distinct, not hidden by scutum. Abdomen rather scantily haired, about 6–8 hairs on each tergite. Hypopygium (fig. 7*j*) with scarcely a trace of lobes on coxite; style widened apically and rather square-ended; anal point moderately long and stout. Last two tarsal segments subequal in length, fourth over twice as long as broad. Empodium fully as long as claws. Wings (Plate XVIII, fig. 17) with the anal lobe only very slightly indicated; costa very short, ending at three-fourths of the wing-length just beyond middle of Cu_1. Cubital fork sharply pointed at base, Cu_2 bent, neither Cu_1 nor Cu_2 quite reaching wing-margin. Wing-length 1·2 mm.

Llyn Gwynant, Carnarvon, 1 ♂ and Corriegills, Arran, 1 ♂ (*F.W.E.*).

S. (S.) angusta, sp. n. ♂. Body black, slightly shining; pleural patch yellow; femora blackish, tibiae and tarsi brown; halteres black. Antennae with dark plume, A.R. about 0·7; one rather longer hair among pubescence at tip (fig. 8*j*). Pronotum less developed than in other species of the genus, hardly visible dorsally. Abdomen almost bare, only 3–5 hairs on each tergite. Hypopygium (fig. 7*l*) with three well-marked lobes on inner aspect of coxite, one dorsal, two ventral. Posterior tibiae and tarsi with short hair. Last two

tarsal segments about equal in length, fourth nearly twice as long as broad. Empodium about as long as claws; no pulvilli. Wings (Plate XVIII, fig. 15) narrow, practically no anal lobe; venation as shown.

♀. Middle antennal segments somewhat oval; sense-bristles very short and slender; terminal segment longer than the two preceding together, pubescent. Shoulders and prescutellar space yellowish, scutal stripes almost separate. Costa rather distinctly produced. R_1 and R_{4+5} closer together than in ♂, latter relatively longer and reaching nearer wing-tip. *An* longer than in ♂, ending almost opposite *fCu*. Fourth tarsal segment rather shorter. Wing-length 1–1·2 mm.

Llyn Gwynant, Carnarvon; Harrow Weald, Middlesex; Skipwith, Yorks.; and Knebworth, Herts. (*F.W.E.*). Evidently nearly allied to *C. forcipatus*, Goet., which has A.R. 1·2 and a rather different hypopygium. The ♀ from Skipwith has the scutal stripes fused and the shoulders only indistinctly yellow.

S. (S.) conjuncta, sp. n. ♀. Dull black; shoulders and wing-base yellow, scutellum and venter brownish. Legs rather light brownish; halteres pale. Last antennal segment barely as long as the two preceding, pubescent, with a short terminal hair. Pronotum reduced as in *S. angusta*, hidden by front of scutum, which is very little arched. Fourth tarsal segment rather shorter than the fifth, and not much longer than broad. Wings (Plate XVIII, fig. 14) without anal lobe. R_1 not much more than one-third as long as R_{4+5}, which is almost entirely fused with the costa, almost as in *Corynoneura*, though without forming a conspicuous "clavus"; the combined costa and R_{4+5} end at about three-quarters of the wing-length, well before level of tip of Cu_1. Cu_2 not reaching margin, the bent-down portion being obsolete; Cu_1 also not quite reaching margin; *An* not nearly reaching *fCu*, which is far beyond *r-m*, this last very short. Wing-length 0·85 mm.

Epping Forest (Wake Valley Pond), viii.1919, vii.1920, and vii.1926 (*F.W.E.*); ♀ only found on each occasion. On three visits in 1929 I could not find the species.

This species may not be a true *Smittia*, although it has much in common with the last two. The bare eyes and simple hind tibia will distinguish it from any *Corynoneura* except *C. morosa*, Edw., which has a much shorter costa; further, there is no trace of the false vein which occurs in all *Corynoneura* on the outer half of the wing below the anterior margin.

S. (S.) brevifurcata (Edw., 1926). ♂. Dull black, legs and halteres dark brownish, tibiae and tarsi lighter. Antennal plume dark, A.R. about 1·5. Costa not produced; wings (Plate XVIII, fig. 18) with cubital fork very short, Cu_2 straight; a distinct transverse fold beyond end of *An* running parallel with Cu_2. ♀. Unknown. Wing-length 1·8 mm.; lobe obtuse. Over seaweed, Somerset and Dorset coasts.

S. (S.) albipennis (Goet.). Dull black in both sexes, including femora and halteres. Costa strongly produced (more so in ♀) but not nearly reaching wing-tip, owing to shortness of R_{4+5}, which ends above middle of Cu_1. Cu_2 straight, *fCu* very far beyond *r-m*. Lobe only slightly indicated. No transverse fold beyond end of *An*. Wing-length 1 mm. Welwyn, Herts.; Witherslack, Westmorland, and Killarney (*F.W.E.*).

CORYNONEURA, Winn.

R_1 and R_{4+5} entirely fused with one another and almost entirely so with the thickened costa, forming a "clavus" which extends less than half the wing-length in ♂ and about

one-half to two-thirds of the wing-length in ♀; in the latter sex the clavus is thicker. A false vein commences at *r-m*, runs below the clavus and then close to the anterior margin almost as far as the wing-tip. Wing-membrane bare, without macrotrichia or microtrichia. Anal lobe obtuse or absent. Squama bare. Fourth tarsal segment shorter than fifth and more or less cordiform. Antennae of ♂ with 10–13 segments (often indistinctly separated); of ♀ with 6 segments. Very small species, wing-length under 2 mm.

We have over a dozen British species, placed in two distinct subgenera. The genus is very distinct from others of the ORTHOCLADIINAE, although one or two species placed in *Smittia* show some approach to it.

Subgenus **Thienemanniella,** Kieff.

(Including *Microlenzia*, Kieff., 1925*a*.)

Hind tibiae not swollen and without apical projection on inner side. Front trochanters keeled but evenly rounded above. Costa extending to about two-fifths of wing-length and nearly to *fCu* in ♂, beyond middle of wing and beyond *fCu* in ♀. *An* curved down at tip and reaching to or beyond *fCu*; lobe present but obtuse. Tergites 2–4 of ♂ abdomen each with a transverse row of 5–7 bristly hairs near base. Eyes usually pubescent.

Six British species, two of which have bare eyes and apparently fit Kieffer's definition of *Microlenzia*, which I do not consider worth separating.

C. (T.) majuscula, Edw., 1924*b*. Body of ♂ almost completely black, shoulders and pleural membrane indistinctly yellowish. Antennae of ♂ distinctly 13-segmented, last segment as long as preceding 8–10 together, tip somewhat swollen, segment 9 not twice as long as broad. Hypopygium with large basal lobe. ♀ with thorax largely yellow, scutal stripes distinct and black, scutellum mainly yellow. Anal area of wing well developed, especially in ♀. Wing-length 1·8 mm. Suffolk, Cambs., Oxford.

C. (T.) lutea, Edw., 1924*b*. ♂ with shoulders, margin of scutum, upper part of pleurae, and sides of basal abdominal segments rather distinctly yellow; scutal stripes often more or less separated. Antennae 13-segmented, but last two joints indistinct; last segment as long as preceding 8 together, tip not or scarcely swollen. ♀ almost completely yellow, scutal stripes light brownish, middle one sometimes a little darker. Wings as shown in Plate XIX, fig. 2. Wing-length 1·3–1·5 mm. Beds.; Herts.; Wilts. Also Staveley, Westmorland. I have previously confused this with *C. vittata*.

C. (T.) vittata, Edw., 1924*b*. ♂. Resembles *C. lutea* in colour; scutal stripes more or less separate, area in front of scutellum dull brownish-yellow. Antennae 13-segmented, but last two joints very indistinct; segments 11–13 together about as long as preceding 8, terminal segment therefore relatively shorter than in *C. lutea*; segment 9 about twice as long as broad. Hypopygium with large basal lobe as in the last two. Type from Newtown, N. Wales; the specimens previously recorded from Oxford are *C. lutea*.

A number of ♂ specimens from Ilkley (*Grace*) and Temple Sowerby, Westmorland (*F.W.E.*) agree in antennal structure with the type of *C. vittata*, but the scutum is almost entirely black, and the lobe of the hypopygium is smaller. A ♀ associated with the Ilkley specimens (which I wrongly recorded in 1924 as *C. clavicornis*) is coloured like *C. majuscula*, but the anal area of the wing is somewhat more obtuse.

C. (T.) clavicornis, Kieff. Differs from the last three in having antennae of ♂ definitely only 11-segmented, last segment only as long as preceding 3

together, segment 9 fully three times as long as broad. Scutal stripes of ♂ fused; of ♀ separate and black, median stripe abbreviated behind; scutellum of ♀ black. Anal area of wing much more obtuse than in the last three. Wing-length 1 mm. Devon, Salop, Yorks., Arran; by hill streams.

C. (T.) morosa, Edw., 1924*b* (? *fusca*, Kieff., 1925*a*). Wholly black in both sexes, except for brownish tibiae and tarsi and yellowish halteres. Antennae of ♂ in some positions appearing to have 13 segments, last only as long as preceding two, oval in shape, without verticil at base and with very little short pubescence towards tip; in other positions the last one or two joints are not distinguishable and the antenna appears 12- or 11-segmented, last segment clavate, with one or two verticils on basal portion. Antennae of ♀ shorter than in the other species of the subgenus, 2–5 at most as broad as long, 6 as long as 3–5 together. S. Devon and Killarney (*F.W.E.*); Melkinthorpe, Westmorland (*Britten*).

C. (T.) flavescens, sp. n. ♂. *Head* black, including most of face; mouth-parts rather light brownish. Eyes bare. Antennae blackish, plumes dark and not very dense; apparently 12-segmented; last segment strongly clubbed and as long as preceding 3, provided with only one basal verticil and the usual apical pubescence; basal part of terminal segment including the verticil appears in some positions to be divided off from the clubbed apex, the antenna then appears 13-segmented, with the last segment as long as the preceding 2. *Thorax* with clear yellow ground-colour, rather strongly pruinescent dorsally. Prothorax yellowish. Scutal stripes well separated, dull black. Scutellum and a small area immediately in front of it dark brown. Postnotum black. Pleurae yellowish above, dark brown below. *Abdomen* wholly black, no yellow on basal segments. Hypopygium (fig. 7*n*) with styles short, almost oval, with long terminal spine; coxites with basal half somewhat thickened, but without lobe. *Legs* brownish; trochanters yellow; knees somewhat darkened. *Wings* (Plate XIX, fig. 1) with costa extending to fully two-fifths, ending scarcely before base of cubital fork. Halteres yellow. Wing-length 1·3 mm.

Staveley, Westmorland, vi.1929, type ♂ (*F.W.E.*). Killarney, 2 ♂♂ (*F.W.E.*). This is possibly *C.* (*Microlenzia*) *flava*, Kieff. (1925*a*), of which the ♀ alone has been described and is said to be entirely yellow.

Subgenus **Corynoneura,** s. str.

(*Bauseia*, Kieff.)

Hind tibiae somewhat swollen at tip, obliquely truncate and with a conspicuous apical projection on inner side. Front trochanters with a more or less conspicuous flat dorsal expansion on apical half or more. Costa extending from scarcely one-third to about two-fifths of wing-length and ending far before *fCu* in ♂; to about middle of wing and not quite to *fCu* in ♀. *An* straight and not reaching *fCu*; lobe absent, hind margin of wing running straight from alula. Tergites 2–5 of ♂ abdomen each with a single mid-dorsal bristly hair, sometimes also with a smaller one near each lateral margin. Eyes bare.

The genotype of *Bauseia* (*antennalis*, Kieff., 1923*c*) is evidently closely allied to *C. coronata*, the characters on which this genus was founded being the presence of 12 segments in the ♂ antenna and the absence of the cross-vein *r-m*. The number of antennal segments is variable in different species; *C. minuta*, Winn., has only 10 (as stated by Winnertz and confirmed by my

examination of the type); *C. celeripes* has 13. The cross-vein is always very short and difficult to see and may be absent in individual specimens.

The eight British species may be arranged in three groups.

Group A.

Extreme tip of antenna in both sexes with a rosette of hairs (fig. 8, *l*, *m*) which are often onger in ♂ than in ♀; a portion of the antenna before the rosette is bare. Hypopygium without specially developed internal basal appendages.

This group includes *C. minuta*, Winn., which has not yet been found in Britain; it differs from our species in having the antennal rosette much larger and the last segment shorter.

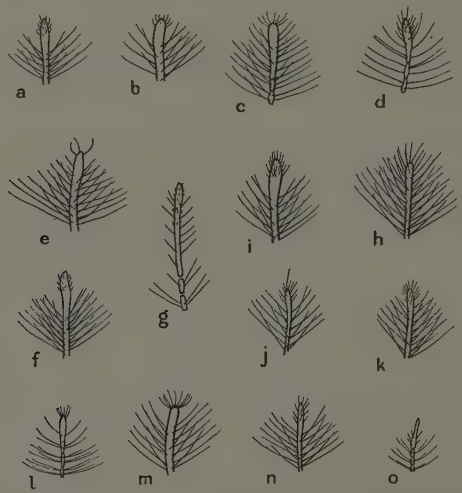

Fig. 8.—Tips of ♂ antennae of species of *Spaniotoma* and *Corynoneura*. a, *S.* (*Eukiefferiella*) *hospita*, sp. n. b, *S.* (*E.*) *calvescens*, sp. n. c, *S.* (*E.*) *coronata*, sp. n. d, *S.* (*E.*) *camptophleps*, sp. n. e, *S.* (*Orthocladius*) *tripilata*, sp. n. f, *S.* (*O.*) *minor*, sp. n. g, *S.* (*O.*) *feminea*, sp. n. h, *S.* (*Limnophyes*) *minima*, Mg. i, *S.* (*Smittia*) *recta*, sp. n. j, *S.* (*S.*) *angusta*, sp. n. k, *S.* (*S.*) *trilobata*, sp. n. l, *C. celtica*, Edw. m, *C. coronata*, Edw. n, *C. scutellata*, Winn. (*innupta*, Edw.). o, *C. carriana*, Edw.

C. (C.) celtica, Edw., 1924*b* (? *brevinervis*, Kieff., 1925*g*). Antennae of ♂ (fig. 8*l*) 10–11 segmented, last only as long as the preceding 2 or 3 together, with short terminal rosette of at least 5–7 hairs and one basal verticil. Thorax of ♂ black; scutal stripes of ♀ more or less distinctly separate, scutellum black. Wing of ♂, Pl. XIX, fig. 3. Wing-length 0·7–0·8 mm. N. Wales; S. Devon. Also Staveley, Westmorland (*F.W.E.*).

C. (C.) lobata, Edw., 1924*b*. Antennae of ♂ 11-segmented, last as long as the preceding 4–6, with short terminal rosette and numerous long hairs towards base. Lobe of coxite very prominent. Scutal stripes of ♀ well separated. Wing-length 1·0–1·4 mm. Arran; Herts.; Cambs.; Devon.

C. (C.) lacustris, Edw., 1924*b*. Antennae of ♂ 13-segmented, last segment as long as preceding 4. Hypopygium somewhat as in *C. lobata*, but style

without subapical excision. Thorax almost all black in both sexes. Wing-length 1·2–1·5 mm. Arran; Manchester; N. Wales. Also Brothers' Water, Westmorland (*F.W.E.*).

C. (**C.**) **coronata,** Edw., 1924*b*. Antennae of ♂ 12-segmented, last segment as long as the preceding 8; rosette (fig. 8*m*) larger than that of *C. lobata*. Scutal stripes of ♀ well separated, scutellum partly or all yellow. Wing-length 1·5–1·7 mm. Suffolk; Beds.; Wilts.; Oxford.

C. (**C.**) **fuscihalter,** sp. n. ♀. General colour dark brownish, including antennae, palpi, legs, and halteres; ground-colour of scutum obscure yellow, stripes separate. Antennae short, segments 4 and 5 almost globular, 6 scarcely as long as 4 and 5 together and rather more slender, with only about 4 short hairs projecting forwards at tip. Wings (Plate XIX, fig. 4) with costa not reaching middle; cubital fork pointed at base, Cu_2 straight. Wing-length scarcely 0·7 mm. Epping Forest, 21.v.1929, 2 ♀♀ (*F.W.E.*).

This is the smallest species of the genus and indeed of the family known to me. It is the only *Corynoneura* I have seen which possesses dark halteres. *C. fusciclava*, Kieff. (1925*g*) is also said to have dark halteres, but is apparently larger, and the ♀♀ is not described.

Group B.

Tip of antennae in both sexes pubescent for a distance at least as long as its breadth (fig. 8*n*), the hairs not aggregated into an apical rosette. Hypopygium with strongly chitinised internal basal appendages (fig. 7*m*).

This group includes *C. scutellata*, Winn., which according to Coquillett's designation is the genotype, although on account of the absence of a distinct antennal rosette it does not entirely correspond with Winnertz's diagnosis of the genus.

C. (**C.**) **celeripes,** Winn. (*atra*, Winn.). Black, scutal stripes almost completely fused even in the ♀. Antennae of ♂ 13-segmented, last segment as long as the preceding 8. Hypopygium with large lobe on coxite. Wing-length 1·2 mm. Herts.; also Epping Forest.

C. (**C.**) **scutellata,** Winn. (*innupta*, Edw.). Antennae of ♂ 11-segmented, last segment (fig. 8*n*) as long as the preceding 6–8. Hypopygium with lobe very slight. Scutal stripes of ♀ well-separated. Common.

A specimen from Staveley, Westmorland (*F.W.E.*) differs somewhat in the form of the style from those previously figured by me, but the other parts of the hypopygium (fig. 7*m*) are quite similar.

Group C.

Extreme tip of antenna bare, though the last segment bears some fine pubescence before the tip (fig. 8*o*). Femora somewhat thickened, especially front pair. Costa of ♂ longer than in the other groups (Plate XIX, fig. 5).

C. (**C.**) **carriana,** Edw., 1924*b* (? *acuticornis*, Kieff., 1912*b*; *crassipes*, Kieff., 1925*g*). Antennae of ♂ with the plume very poorly developed, only a few hairs on each segment; last (11th) segment as long as preceding 3 or 4. Scutal stripes well separated in both sexes. Wing-length about 1·0 mm. Cheshire; Notts.; also found in abundance on Hickling Broad, Norfolk, viii.1926 (*P. A. Buxton*).

Subfamily CLUNIONINAE.

The main distinction of this subfamily as proposed by Kieffer was the absence of any comb at the tip of the hind tibia. I do not regard this character by itself as of very great significance, as the comb appears to have been lost (or remained undeveloped) in several unrelated groups. The marine genera of Kieffer's CLUNIONINAE, however, have several other striking features in common, and it appears justifiable to retain the subfamily on these grounds. The only non-marine species belonging here are some *Telmatogeton* living in mountain streams in the Hawaiian islands. I would define the subfamily thus :—

Eyes round. Front without a median longitudinal impressed line, but usually with a transverse fold above antennae. Face very small. Male antennae never plumose. Sense bristles of ♀ antennae absent or rudimentary. Pronotum completely divided into lateral lobes. Postnotum without distinct median furrow or keel. Suture between sternopleurite and anepisternite absent or but little developed, extending forward only a short distance

FIG. 9.—Side-view of thorax of (*a*) an Orthocladiine (*Cardiocladius capucinus*, Zett.) and (*b*) a Clunionine (*Psammathiomyia pectinata*, Deby), showing presence of anepisternal suture (*aes*) in the former and its absence in the latter.

from base of middle coxa. Hypopygium permanently inverted after emergence from pupa; anus opening at the end of a membranous tube; styles infolded, but without distinct terminal spine. Legs very long (except in *Clunio*), especially the hind pair. Front coxae enlarged. First segment of front tarsus shorter than the tibia. Front tibia with spur; posterior tibiae with one or two spurs but without combs. Wings (when present) without macrotrichia; *m-cu* absent; venation much as in the ORTHOCLADIINAE, but R_{2+3} hardly distinguishable.

All three European genera have been found in Britain; each with a single species.

CLUNIO, Hal.

Eyes pubescent. Mouth-parts reduced, the palpi consisting of a single small segment. Antennae of ♂ 11-segmented, of ♀ 7-segmented, in both sexes almost bare. Hypopygium very large, at least as large as the thorax and quite half the total length of the abdomen. Cerci of ♀ not long. Legs rather stout; each tibia with a single spur. Tarsi all short, fourth segment subcordiform, fifth simple. Female quite wingless. Male wings (Plate XIX, fig. 7) well developed, broad, surface without microtrichia. Lobe large and rather sharply angled, but separated from the alula by a narrow area. R_1 (in the British species) very short and indistinct, not a quarter as long as R_{4+5}, which ends well before the wing-tip. Costa not produced. Cu_2 strongly recurved. Squama bare.

C. marinus, Hal. (*bicolor*, Kieff.). Brownish; ♂ antennae with the first and last flagellar segments pale, the rest dark; abdomen of ♂ with base and venter greenish in life. Coasts of Ireland, Isle of Man and English Channel.

THALASSOMYIA, Schin.

(*? Campontia*, Johnston; *Scopelodromus*, Chevrel; *Galapagomyia*, Johnson.)

Eyes bare. Palpi 4-segmented and moderately long. Antennae alike in the two sexes, 7-segmented, last segment with a nipple-like terminal projection; no sense-bristles. Hypopygium very small; ♀ cerci short and rounded. Legs long, especially the hind pair. Posterior tibiae each with two spurs. Third tarsal segment bilobed at tip, fourth short and strongly cordiform, fifth not lobed at tip. Empodium very large. Wings (Plate XIX, fig. 6) fully developed in both sexes, broad, surface with small but distinct microtrichia. Lobe large and right-angled, arising immediately beyond alula as usual. R_1 moderately long. R_{4+5} curved and reaching almost to wing-tip. Base of cubital fork not much beyond *r-m*, Cu_2 gently curved. Squama fringed.

T. frauenfeldi (Schin.) (*pedestris*, Woll.; *isemerinus*, Chevr.). A dark brown insect without definite ornamentation. Recorded from coasts of Cornwall, Devon, Somerset and Suffolk.

Wollaston's types of *Chironomus pedestris* (from Madeira) are in the British Museum and agree with *T. frauenfeldi*. The name *pedestris* is unfortunately preoccupied by *Chironomus pedestris*, Mg.

PSAMMATHIOMYIA, Deby.*

Eyes bare. Mouth-parts reduced, palpi consisting of one or two short segments. Antennae 7-segmented in both sexes, almost bare, last segment with a short nipple-like projection. Hypopygium small. Cerci of ♀ long and pointed. Legs long, especially hind pair. Each tibia with a single very short spur. Fourth tarsal segment somewhat shorter than fifth and indistinctly cordiform; fifth trilobed at tip, median lobe especially long and finger-like. Empodium very large. Claws of ♂ toothed. Wings (Plate XIX, fig. 8) reduced in both sexes, without definite venation. Squama bare. Halteres present.

P. pectinata, Deby. A small brownish species; length of body about 2–2·5 mm., wing barely 1 mm. Styles of ♂ with numerous short spinules on outer surface (irregularly arranged, not forming a comb as stated in original description). Wings in the specimens examined obliquely truncate at tip, where fringe is interrupted. St. Ives, Cornwall, viii.1928 (*Buxton*). Taken on surface of pools below the *Fucus* zone (therefore only exposed at low tide) in company with *Spaniotoma thalassophila*, Goet.

Subfamily CHIRONOMINAE.

The CHIRONOMINAE were divided by Kieffer into four tribes, the Clunionariae, Diamesariae, Orthocladiariae and Chironomariae, which are regarded in this paper as forming separate subfamilies. The first (as defined by Kieffer) was in my opinion an unnatural group, and I would refer some of its genera to the ORTHOCLADIINAE, though *Corynocera* and its allies seem to be rather nearly related to *Chironomus* and should be included in the present subfamily.

The remainder of the subfamily CHIRONOMINAE as here understood consists

* Original incorrect spelling *Psamathiomya*.

of the old genera *Chironomus* and *Tanytarsus*. Each of these has been split by Kieffer into a large number of divisions, some of which are certainly natural groups, though the greater number are based upon trivial characters which are often extremely difficult to appreciate even with a high magnification, and are therefore liable to misinterpretation; such are especially the characters drawn from the shape or structure of the pulvilli. These, and small details of hypopygial structure are best treated as of specific importance only. On the other hand, I would attach some importance to two characters which were entirely overlooked by Kieffer: these are the form of the pronotum and the presence or absence of a fringe on the squama of the wing. The characters of the CHIRONOMINAE are the following:—

Cross-vein *m-cu* absent. R_{2+3} present, simple, generally reaching costa less than halfway between the tips of R_1 and R_{4+5}. Costa almost always ending abruptly at tip of R_{4+5}. Front tibia seldom with spur (if present it is usually very small and bristle-like). Middle as well as hind tibiae normally with combs composed of basally fused spinules (combs absent in *Corynocera* and a few other cases); one or both spurs short or absent. First segment of front tarsi nearly always longer than tibia (L.R. more than 1). Male styles directed rigidly backwards and without terminal spine; coxites usually with two or more basal appendages.

For the present I propose to recognise as full genera only five groups among the species occurring in Britain. These may be distinguished very readily as follows:—

1. Wings with macrotrichia, at least at the tip . . . . . 2.
   Wings quite devoid of macrotrichia; *r-m* distinct and oblique . . . . 3.
2. Squama fringed; *r-m* distinct and oblique . . . . . *Pentapedilum.*
   Squama quite bare; *r-m* nearly horizontal or indistinct . . . *Tanytarsus.*
3. Eyes widely separated, reniform; all tibiae with long conspicuous spurs (fig. 10*a*); pronotum large, with **V**-shaped emargination above *Pseudochironomus.*
   Eyes with long dorsal projection; front tibial spur absent or indistinct; pronotum otherwise . . . . . 4.
4. Combs of posterior tibiae composed of very short free spinules, without trace of spurs (fig. 10*b*) . . . . . *Graceus.*
   Combs of posterior tibiae composed of longer, basally-fused spinules, at least one comb with spur (fig. 10*e*, *f*, *g*, *h*) . . . . . *Chironomus.*

In this subfamily the basal appendages of the hypopygium are of great taxonomic importance. Of these there may be as many as four pairs—normally two in the *Chironomus* group and three or four in the *Tanytarsus* group—all developed from the region at the base of the coxite. In the case of *Chironomus* these are spoken of by Goetghebuer as *dorsal* and *ventral* appendages; in the case of *Tanytarsus* he refers to them as *dorsal*, *supplementary*, *intermediate* and *ventral* appendages, in the latter case the first and third corresponding to the two pairs of *Chironomus*, the second and fourth being special developments. For the sake of brevity I propose to designate these appendages 1, 1*a*, 2 and 2*a*, 1 and 2 being homologous throughout the subfamily.

The characters used for the definition of the genera and subgenera are found mainly in the tibial spurs and combs. In order to see these clearly it is sometimes necessary to break off a tarsus (preferably of a hind leg) by bending it upwards with the aid of two needles. When this is done, however, the combs

of even the smallest *Tanytarsus* are clearly visible under the high power of a binocular microscope.

The following European genera have not yet been found in Britain :—

Corynocera, Zett. Eyes small and widely separated. Antennae of ♂ without plume, 12-segmented, A.R. under 0·5. Palpi short, 3-segmented. Front with two swellings, not surmounted by tubercles. Front legs long; middle and hind legs short and thick, femora swollen, tarsi shorter than tibiae. Middle and hind tibiae each with two short, smooth spurs, which are not articulated but fused with the tibia; no combs nor hair-tufts. No distinct pulvilli. Wings shortened and distorted, with a tuft of long hair at tip.

Thienemanniola, Kieff. (*Lenziella*, Kieff.). Nearly related to *Corynocera*, but palpi only 2-segmented; frontal swellings each surmounted by a tubercle; middle and hind tibiae with a single short, curved black hook at the tip, immediately behind which is a tuft of hair; wings evenly fringed, without long hair-tuft at tip.

Fleuria, Kieff., 1924 (*Lenziola*, Kieff., 1925). Resembles *Corynocera* in its short, thick posterior legs and absence of plume on ♂ antenna, but palpi 4-segmented; ♂ antennae 8–10-segmented; wings well developed; posterior tibiae with well-developed combs each surmounted by two spurs, as in *Chironomus*. Pulvilli large. Frontal tubercles and tibial hair-tufts as in *Thienemanniola*.

Allochironomus, Kieff. Tibiae, wings and thorax as in the subgenus *Stictochironomus* of *Chironomus*, but ♂ antenna with reduced plume; front tarsi short, L.R. only 0·8; hypopygium of unusual structure, with three pairs of appendages, two arising from near apex of coxite (dorsally and ventrally), the third from base of coxite beneath. This is perhaps to be regarded as an aberrant *Stictochironomus*.

Brunieria, Kieff. By description seems to have a hypopygium like that of *Allochironomus*, but antennal plume well developed and both tibial combs spurred.

Dolichopelma, Kieff. By description seems to resemble *Lauterborniella*, but tibial combs composed of short, free spinules; no spurs.

Protanytarsus, Kieff. Said to differ from *Tanytarsus* in having the antennae alike in the two sexes.

Prochironomus, Kieff. Hypopygium as in *Tanytarsus* but wings said to be quite bare. This and *Protanytarsus* are probably only aberrant species of *Tanytarsus*.

Goetghebueria, Kieff. Said to differ from *Tanytarsus* in having a small comb on the front tibia. Should probably be included in *Tanytarsus*.

Synchironomus, Lenz (1921). Based on larva and pupa of *Ch. fusiformis*, Kieff.

In addition to the above a number of other names have been proposed by Kieffer for European species which seem to me hardly distinguishable from *Tanytarsus*. These are (excluding those mentioned in the notes below): *Allotanytarsus*, *Clinotanytarsus*, *Fournieria*, *Hexatanytarsus*, *Holtedahlia*, *Lauterbornia*, *Lundströmiella*, *Lundströmiola*, ? *Microchironomus*, *Monotanytarsus*, *Natvigia*, *Oeklandia*, *Ortroya*, *Tetratanytarsus*, *Tomotanytarsus*, *Tritanytarsus*, *Xenotanytarsus*. Two or three of these could perhaps be recognised as subgenera.

Pentapedilum, Kieff.

Wings hairy, at least at tip, both on membrane and veins. Squama fringed. Cross-vein distinct and oblique; *An* running rather close to *Cu* and more or less curved down at tip, as in *Chironomus*. Anal area generally well developed. No frontal tubercles. Pulvilli always distinct. Hypopygium with appendage 1 chitinised and almost bare; 2 long, with long curved hairs distally; 1*a* and 2*a* both absent.

In this genus I would include a few species which have till recently been included in *Tanytarsus* (subgenus *Calopsectra*); they are, however, much more

nearly related to *Chironomus*, from which they differ only in the more or less hairy wings. Differences occur in the tibial spurs, and ♂ antennae, parallel with those seen in *Chironomus*, and on these characters four subgenera may be recognised.

1. Tibial combs each with a short spur (fig. 10c) . . . . . 2.
   One comb with a long spur, other unarmed (fig. 10*d*) . . . . *Pentapedilum.*
2. L.R. barely 1 . . . . . *Sergentia.*
   L.R. at least 1·25 . . . . . 3.
3. ♂ antennae 12-segmented . . . . . *Kiefferulus.*
   ♂ antennae 14-segmented . . . . . *Phaenopsectra.*

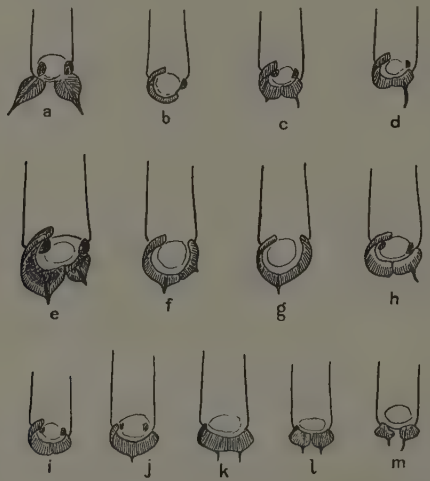

Fig. 10.—Diagrams showing form of right hind tibial combs of Chironominae, in postero-dorsal view after removal of tarsus. a, *Pseudochironomus prasinatus*, Staeg. b, *Graceus ambiguus*, Goet. c, *Pentapedilum flavipes*, Mg. d, *P. sordens*, v.d.W. e, *Chironomus* (s. str.) *plumosus*, L. f, *C.* (*Endochironomus*) *tendens*, F. g. *C.* (*E.*) *dispar*, Mg. h, *C.* (*Microtendipes*) *pedellus*, De G. i, *Tanytarsus* (*Micropsectra*) *brunnipes*, Zett. j, *T.* (*Lundströmia*) *praecox*, Mg. k, *T.* (*L.*) *penicillatus*, Goet. l, *T.* (s. str.) *tenellulus*, Goet. m, *T.* (s. str.) *ejuncidus*, Walk.

Subgenus **Sergentia,** Kieff.

Antennae of ♂ 14-segmented, A.R. at least 3; of ♀ 7-segmented (not 6 as stated by Goetghebuer). Pronotum fairly well developed, reaching front margin of scutum and not divided in middle. ♂ styles stout, with some short hairs at tip on inner side, appendages as in *Phaenopsectra*. Front tibia without spur; posterior tibial combs each with a short spur. L.R. 0·95–1. Pulvilli broad. Wings hairy only towards tip.

The single British species is probably the same as the genotype (*profundorum*, Kieff.). On the other hand, it should be noted that the species wrongly determined by Kieffer as *coracinus* (= *koenigi*, Kieff.) is the type of the subgenus *Lauterbornia* of *Tanytarsus*. These two are superficially very similar.

On account of the shortened front tarsi *Sergentia* might be confused with *Metriocnemus*.

P. (S.) coracinum (Zett.) (? *profundorum*, Kieff.). Dull black; legs dark; front tarsus of ♂ with long beard; wings whitish. Rydal and Ullswater (*Verrall*); Vrynwy (*Newstead*); Eccup, Yorks. (*Hincks*); Glencorse (*Grimshaw*).

Subgenus **Kiefferulus,** Goet.

Antennae of ♂ 12-segmented, A.R. over 3; of ♀ 6-segmented. Pronotum reaching up to front margin of scutum, but thin and bilobed. ♂ styles with a row of stiff bristles on inner side at tip; appendage 1 bare, 2 very broad, with long curved hairs but without very long apical hair. Front tibia without spur; posterior tibial combs each with a short spur. Pulvilli broad. Wings broad, hairy towards tip.

One British species, which except for the hairy wings and absence of frontal tubercles might be included in the subgenus *Chironomus*. The Australian *C. lativalva*, Kieff., has quite the same structure of hypopygium and may belong here.

P. (K.) tendipediforme, Goet. Resembles *Chironomus dorsalis*. Green; scutal stripes reddish to black; abdomen largely dark. L.R. 1·3; no tarsal beard. Wicken; Letchworth; Epping; New Forest (*F.W.E.*); Wood Walton (*Rothschild*).

Subgenus **Phaenopsectra,** Kieff.

(*Lenzia*, Kieff.)

Antennae of ♂ 14-segmented, A.R. about 2; of ♀ 7- (sometimes 6-) segmented. Pronotum more or less reduced. ♂ styles without long hairs on inner side; appendage 1 with median hair, 2 usually with two rather long apical hairs. L.R. 1.2–1·35. Front tibia without distinct spur; combs of posterior tibiae each with a short spur (one spur sometimes hardly distinguishable). Pulvilli broad. Anal area of wing well developed, membrane rather densely hairy.

In most respects except the hairy wings *Phaenopsectra* resembles the subgenus *Endochironomus* of *Chironomus*. We have two British species; the first (under the name *leucolabis*) seems to have been the type of Kieffer's genera *Phaenopsectra* and *Lenzia*, and has also been mentioned by Goetghebuer under *Endochironomus*.

The inclusion of *Tanytarsus punctipes* in the subgenus raises the question as to whether the proper name for it is not *Tanytarsus*, since Coquillett in 1910 designated *T. punctipes* as the type of van der Wulp's genus. This designation, however, was invalid because Kieffer in 1909 had already restricted *Tanytarsus* to the species without pulvilli, and *T. punctipes* (as I interpret it) has distinct pulvilli. Another species must therefore be chosen as the type of *Tanytarsus*, and I would hereby select *T. signatus*, v.d.W., which conforms with Kieffer's restriction, and about the identity of which there can be no question.

In addition to the two British species, Zetterstedt's *Chironomus incomptus* belongs here and not to *Metriocnemus* as has been supposed by some authors. All have pale halteres.

P. (P.) flavipes (Mg.) (*albipes*, Zett.; *tenellus*, Zett.; *albiforceps*, Goet.; *leucolabis*, Kieff.). Body all blackish, scutal stripes somewhat shining; legs pale yellow, usually also ♂ styles; antennal plume dark. Common.

P. (P.) punctipes (Wied.) (*abdominalis*, Staeg.; *semiviridis*, Goet.; ? *albiventris*, Kieff.). Thorax almost all shining black (♂♀); abdomen pale green; antennal plume and legs whitish. Locally common.

Subgenus **Pentapedilum,** Kieff.

Antennae of ♂ 14-segmented, A.R. not much over 1; of ♀ 6-segmented. Pronotum reduced, not reaching up to front margin of scutum. ♂ styles with long hairs on inner side; appendage 1 usually with one or two long hairs; 2 with a long apical hair. Front tibia usually with very short spur; posterior comb of middle tibia and outer comb of hind tibia with long spur, other combs unarmed. Pulvilli moderate. Anal area of wing obtusely rounded. Wings hairy on most of the surface; *fCu* generally well beyond base of *Rs*.

In all respects except the hairy wings the species of this subgenus resemble those of the subgenus *Polypedilum* of *Chironomus*, and the two should perhaps be united. As in the case of *Polypedilum*, the pulvilli are said by Kieffer to be split each into two, but I have not been able to detect this in any of our species. *P. tritum*, Walk. (which may be synonymous with the genotype, *P. stratiotale*) has oval pulvilli, the thickened edges of which might possibly in some mounts be mistaken for separate pulvilli.

We have four British species of this subgenus. In the first three the knob of the halteres is darkened; the fourth, with pale halteres, is very distinct on account of the slight clouds on the wings. Staeger's *Ch. latus* belongs to this subgenus; it has pale halteres as in *P. nubens*, but the thorax is lighter.

P. sordens (v.d.W.). Wings densely hairy, body also rather more hairy than usual. Dark brown, posterior margins of abdominal tergites conspicuously pale. L.R. about 1·2. Rather common.

P. tritum (Walk.) (? *stratiotale*, Kieff.; *longiseta*, Kieff., Goet.). Smaller than the last; light brown, ♀ lighter than ♂; scutal stripes separate, in ♀ not very dark, the middle one often obsolete. Abdomen unicolorous. L.R. 1·4–1·6. Rather common.

P. uncinatum, Goet. Similar in all structural respects to *P. tritum*, but darker, almost black in colour, scutal stripes fused in both sexes. The hypopygium of our specimens differs very little from that of *P. tritum*, and does not agree well with Goetghebuer's figure, but the identity has been confirmed by Dr. Goetghebuer. Locally abundant.

P. nubens, sp. n. Body blackish; thorax with strong grey reflections, especially between the stripes; ground-colour of thorax in ♀ more brownish; posterior margins of tergites in ♀ pale; legs brownish, darker in ♂; halteres yellow. Antennae dark in both sexes; A.R. about 1·5; ♀ antennae 6-segmented, 3 and 4 with rather long necks, 5 with a shorter but still distinct neck; 6 hardly longer than 4 and 5 together. Hypopygium almost as in *P. flavipes*; appendage 1 slender, without median hair. L.R. about 1·4. Spur of posterior tibiae only about as long as the comb, and quite straight (in *P. tritum* it is much longer and curved). Wings (Plate XIX, fig. 15) moderately hairy all over; a slight dark grey cloud below tip of R_{4+5} and another in anal cell, both more distinct in ♀ than in ♂; when the wing is viewed obliquely veins *M*, Cu_1 and Cu_2 appear seamed with grey, and there are slight clouds in bases of cells R_5 and Cu_1. Venation normal; *fCu* slightly beyond *r-m*. Wing-length 2·5–3 mm. Lakes Windermere and Killarney (*F.W.E.*); Rannoch, Perth (*Grimshaw*).

Pseudochironomus, Mall.

(*Proriethia*, Kieff.)

Wings without hair on membrane or veins (except costa and radius). Venation as in *Chironomus*, except that R_{4+5} ends distinctly before tip of *M* (Plate XIX, fig. 9). Squama

with complete fringe. Eyes slightly reniform, very widely separated above. Antennae of ♂ 14-segmented, of ♀ 7-segmented. Palpi long. Pronotum large, reaching up to front edge of scutum, but with a deep V-shaped excision. Hypopygium with appendages 1 and 2 present, of peculiar form. Front tibia with a long spur; L.R. slightly less than 1. Posterior tibiae with two long spurs (fig. 10*a*), the bases of which are much enlarged and crenulate (apparently representing the first stage in the development of the combs of *Chironomus*). Pulvilli large.

The combination of the above characters seems sufficient for the separation of this genus from *Chironomus*. I have compared paratypes of the genotype (*P. richardsoni*, Mall.) with the British species, and find that they are similar in almost every respect except colour. The tibial spurs are not truly of the *Orthocladius* type as supposed by Malloch, and the slightly shortened front tarsi are also found in several quite unrelated species of the subfamily (*G. ambiguus*, Goet., *Ch. pilicornis*, F.. *Pent. coracinum*, Zett., *Tan. koenigi*, Kieff., etc.).

P. prasinatus (Staeg.) (*ploenensis*, Kieff.). A medium-sized bright green species; scutum in ♂ with well-separated black stripes. Slapton, S. Devon (*Verrall*); Wicken, Cambs.; Witherslack, Westmorland (*F.W.E.*); Corrour, Inverness (*Grimshaw*); Clare Island, Castlebar Ballin, and Coolbarren Lough, N. Ireland (*Grimshaw*).

GRACEUS, Goet.

Antennae of ♂ with 14 segments, of ♀ with 7. Palpi of 4 segments, but unusually short, in ♂ segment 4 shorter than 3, in ♀ 2, 3 and 4 about equal in length and only twice as long as broad. Eyes with long dorsal projection. No frontal tubercles. Pronotum fairly well developed, not completely divided in middle. Male hypopygium much as in *Chironomus*, s. str.; styles rather large, oval; appendage 1 curved, 2 much swollen apically, moderately long, with long curved hairs. Tibial combs very short, hardly discernible in the dry specimen; under a high power (fig. 10*b*) they appear to be composed of semi-free spinules; no sign of a spur on either comb. Pulvilli present but small. Wings rather narrow, but venation as in *Chironomus*; costa not retracted. R_{2+3} ending well beyond R_1.

The rather peculiar species described below appears to resemble *Nilomyia* more than any of the other subgenera proposed by Kieffer, although it differs in some respects (notably the short front tarsi) from the genotype. The spinules of the tibial combs are very close together and it is difficult to be certain whether or not they are quite free at the base.

The absence of tibial spurs and reduction of the combs, together with the habits of the imagos, suggests an affinity with the *Corynocera* group.

G. ambiguus, Goet. Blackish, including antennae and legs; halteres rather dark brown. Scutum with slight pruinescence, stripes slightly shining. Pubescence pale. ♂ antennae with the plumes only moderately dense, A.R. about 1·3. ♀ antennae with segments 2 and 3 rather indistinctly separated, 4–6 nearly twice as long as broad, broadest near base, narrowed apically but without distinct necks; 7 as long as 5–6; verticils only moderately long (2·5 times length of segment), none on 7. Palpi of ♂ with segments 2, 3 and 4 gradually diminishing in length, 2 about four times, 3 three times, 4 twice as long as broad. Palpi of ♀ shorter, 2, 3 and 4 subequal, but diminishing in thickness, each little more than twice as long as broad. Hypopygium as figured. Legs stoutish, L.R. 0·8 (♀)–0·95 (♂). Wings rather dark greyish, anterior veins black; lobe rather small and rounded; length 3 mm.

Woking, Surrey, 4.iv. and 10.iv.1915 (*G. C. Champion*); Burnham Beeches, Bucks., 15.iv.1915 (*F.W.E.*). Both sexes flying in great numbers over shallow ponds in heathy districts, not rising more than about an inch above the surface of the water.

Van der Wulp in 1858 figured (without description) the head of a ♂ *Chironomus* with palpi similar to the present species, and attached the name *C. ambiguus* to the figure; I therefore suggested to Goetghebuer the adoption of the name *ambiguus* for this species.

Chironomus, Mg.

Wings without hairs on membrane, or on veins *M*, *Cu* or *An*. Squama with complete fringe (except in subgenera *Lauterborniella* and *Kribioxenus* and one species of *Paratendipes*). Anal area of wing well developed. Cross-vein *r-m* distinct and oblique. Costa (with rare exceptions) ending above tip of *M*; R_{4+5} well removed from R_1 and often somewhat curved down at tip. *An* rather close to *Cu* and almost parallel first with *Cu* and then with Cu_2, the tip of vein *An* being bent down and reaching almost to middle of fork. Eyes not widely separated above, with long dorsal projections. Antennae of ♂ 12–14 segmented, of ♀ 6–7 segmented. Palpi long, fourth segment usually much longer than third. Pronotum variable in development. Hypopygium of ♂ with appendages 1 and 2 usually present, 1*a* absent, 2*a* absent (except in subgenus *Paratendipes*). Combs of posterior tibiae always large, more or less confluent ventrally, occupying at least half circumference of tibia and composed of basally fused spinules.

The very large number of species of the old genus *Chironomus*—nearly 100 have already been found in Britain—renders it very desirable that some division of the genus should be made, but as the structural differences between the species are small, and no very sharp lines of demarcation can be drawn between the various groups, I prefer to retain the genus practically in the sense in which it was defined by van der Wulp. Of the numerous divisions proposed by Kieffer, those based on the form of the tibial spurs and combs seem to be the most reliable, and these characters have the advantage of being unaffected by sex. I therefore accept these divisions as subgenera, supplementing the characters drawn from the tibial spurs by others, especially the form of the pronotum. Among the British species ten subgenera are rather easily distinguished, as follows:—

1. Hind tibial combs each with a short spur (very rarely the outer spur may be wanting) (fig. 10*e*, *f*, *g*) . . . . . 2.
   Hind tibiae with a long spur on the small outer comb, the large inner comb unarmed (fig. 10*h*) . . . . . 7.
2. Pulvilli well developed, at least half as long as claws . . . . . 3.
   Pulvilli absent or scarcely distinguishable . . . . . 6.
3. Pronotum forming a distinct collar, reaching up to front edge of scutum and not completely divided in middle (fig. 11*a*) . . . . . *Chironomus*.
   Pronotum otherwise . . . . . 4.
4. Pronotum reaching up to front edge of scutum, but bilobed (as seen from above) (fig. 11*c*) . . . . . *Endochironomus*.
   Pronotum more reduced, not visible from above (fig. 11*b*, *d–g*) . . . . 5.
5. Scutum not produced forwards; wings not banded (fig. 11*b*) . *Glyptotendipes*.
   Scutum produced forwards over head (fig. 11*d*); wings banded . *Stenochironomus*.
6. Front tibia with short spur; thorax shining black . . . . . *Paratendipes*.
   Front tibia with longish curved spur; thorax green . . . . *Kribioxenus*.

7. Squama fringed . . . . . 8.
   Squama bare . . . . . *Lauterborniella.*
8. Large or medium-sized species; wings unmarked; legs not ringed; thorax usually shining black; R_{2+3} ending in contact with or very near R_1 *Microtendipes.*
   Small to medium size; wings often spotted or clouded or legs ringed; thorax never shining black (in British species); R_{2+3} ending more or less distinctly beyond R_1 . . . . . 9.

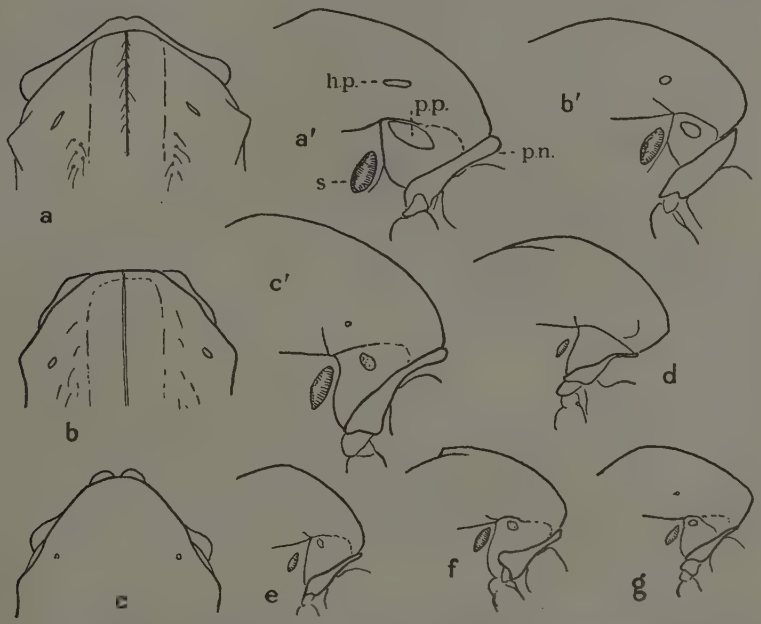

Fig. 11.—Diagrams of front of thorax of different subgenera of *Chironomus*, to show form of pronotum, etc. a and a', *C.* (s. str.) *anthracinus*, Zett., from above and from side. b and b', *C.* (*Glyptotendipes*) *glaucus*, Mg. c and c', *C.* (*Endochironomus*) *dispar*, Mg. d, *C.* (*Stenochironomus*) *gibbus*, F. e, *C.* (*Polypedilum*) *arundineti*, Goet. f, *C.* (*Stictochironomus*) *pictulus*, Mg. g, *C.* (*Microtendipes*) *pedellus*, De G.
pn, pronotum. *p.p.*, prothoracic sensory pit (a structure which has not hitherto been noticed, but which may be found of use in taxonomy; it is specially large in the species of the *plumosus* group). *h.p.*, humeral pit (often useful in taxonomy; cf. subgenus *Trichocladius* of *Spaniotoma*). *s*, spiracle.

9. Scutum with a slight hump in middle (fig. 11*f*); *fCu* below or before *r-m* *Stictochironomus.*
   Scutum without hump in middle; *fCu* at least slightly beyond *r-m* *Polypedilum.*

This key may be supplemented by indicating a few other characters which may be useful in running down certain species or groups :—

1. Antennae of ♂ with 12 segments (the others have 14): *Chironomus, Glyptotendipes, Endochironomus rufipes.*
2. Antennae of ♀ with 7 segments (the others have only 6, segments 2 and 3 not

being separate): *Glyptotendipes, Endochironomus, Paratendipes, Kribioxenus, Microtendipes.*

3. Wings with one or two dark transverse bands: *Stenochironomus, Endochironomus rufipes.*
4. Wings with spots or clouds: *Stictochironomus, Polypedilum, Lauterborniella marmorata.*
5. Wings with *r-m* blackened, otherwise unmarked: *Chironomus* (groups A and B); *Glyptotendipes*; *Stictochironomus.*
6. Tibiae with dark rings: *Stictochironomus.*
7. Thorax all shining black: *Chironomus nigronitans, Endochironomus, Paratendipes, Microtendipes.*
8. Body all green: *Chironomus* (several groups); *Glyptotendipes viridis*; *Endochironomus albipennis* ♀, *Kribioxenus* ♀.

Subgenus **Chironomus,** s. str.

(Including *Cryptochironomus,* Kieff., etc.)

Antennae of ♂ with 12 segments, A.R. usually 3 or more; of ♀ with 6 segments. Frontal tubercles frequently present. Pronotum forming a distinct collar, reaching up to front margin of scutum, where it is often emarginate but not quite divided. Front tibia without trace of spur. Combs of posterior tibiae large, occupying most of circumference of tibia and each with a short spur. Pulvilli always large. Wings without spots or bands, at most with darkened cross-vein. R_{2+3} ending only a little beyond tip of R_1; *fCu* below or slightly beyond *r-m*.

The subgenus *Chironomus* as here defined includes about half the British species of the genus. These may be placed in five groups, very distinct on male characters, but almost impossible to define in the female sex. These groups were all recognised by Kieffer as distinct genera, and it was even proposed by Lenz (1921) to erect one of them (*Cryptochironomus*) to a special subfamily, but I see no justification for treating them as of higher rank than groups of *Chironomus*. They may be distinguished as follows by the characters of the hypopygium:

1. Styles very stout, with hard dorsal keel; appendage 2 long and densely pubescent; tergite trilobed apically (fig. 12*a*, *b*) . . . . . *Group A.*
   Styles not so stout, rarely with dorsal keel; appendage 2 otherwise; tergite not trilobed . . . . . 2.
2. Appendage 2 reaching well beyond end of coxite, with long curved hairs . 3.
   Appendage 2 not reaching beyond end of coxite, without long curved hairs 4.
3. Appendage 2 broad and almost straight (fig. 12*c*) . . . . . *Group B.*
   Appendage 2 narrower, curved ventrally, bare except towards tip (fig. 12*d*) . . . . . *Group C.*
4. Appendage 2 broad, pubescent (fig. 12*l*, *m*, *n*) . . . . . *Group D.*
   Appendage 2 rudimentary or absent (fig. 12*h–k*) . . . . . *Group E.*

Group A.

(*Camptochironomus,* Kieff.)

♂. Ninth tergite trilobed, with a small hairy lobe on each side of the anal point, latter in the form of a deep vertical keel with two dorsal flanges. Appendage 1 rudimentary, 2 very long, with long dense pubescence along the whole of the inner face, but no specially long hairs. Styles unusually thick and horny, with sharp dorsal keel. Large species with large frontal tubercles, milky wings and strongly pruinose thorax.

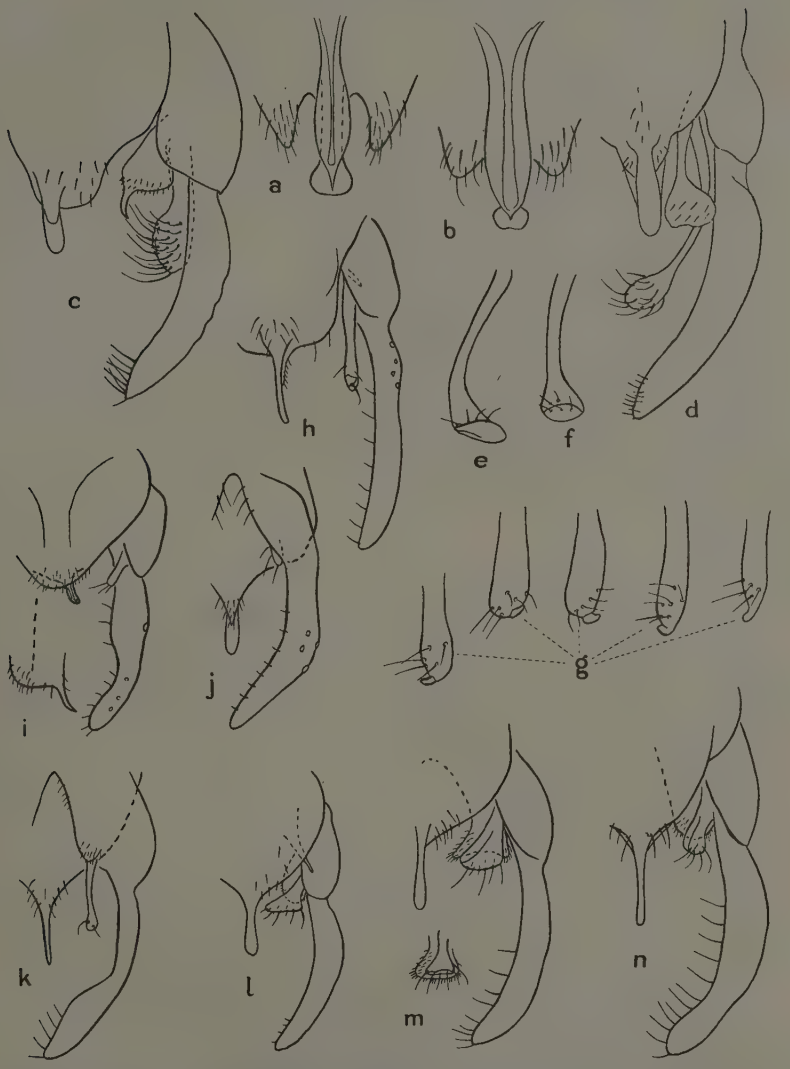

Fig. 12.—Details of ♂ hypopygium of species of *Chironomus*, s. str. a, tip of ninth tergite with anal point of *C. pallidivittatus*, Mall. b, the same part in *C. tentans*, F. c, *C. dissidens*, Walk., from above. d, *C. pulsus*, Walk., from above. e, dorsal basal appendage (app. 1) of *C. nervosus*, Staeg. f, the same, *C. tritomus*, Kieff. g, *C. lobiger*, Kieff., five variations in form of appendage 1. h, *C. digitalis*, sp. n., from above. i, *C. nigronitens*, sp. n., from above. j, *C. virescens*, Mg., from below. k, *C. claviforceps*, sp. n., from below. l, *C. camptolabis*, Kieff. (? var. *laminatus*, Kieff.), from above. m, *C. camptolabis*, Kieff., showing two other variations in form of basal appendages. n, *C. claripennis*, Mall. (?).

Two British species; the second has hitherto been regarded as a mere variety of the first, but I find there is a small but constant difference in the hypopygium, and therefore treat the two as distinct. They superficially resemble *C. plumosus.*

C. tentans, Fabr. (*aprilinus*, Kieff., *nec* Mg.; ? *subaprilinus*, Kieff.; *atrofasciatus*, Kieff.). Scutal stripes black; postnotum black, sometimes narrowly yellowish at base; abdomen mainly black; front femora rather extensively darkened at tip; front tibia in mature specimens often almost entirely black; ♂ front tarsi in some specimens with slight beard; *r-m* darkened. Lateral lobes of ninth tergite short (fig. 12*b*). Wood Walton, Hunts. (*Rothschild*); Bullwell, Notts. (*Carr*); Bramhope, Yorks. (*F.W.E.*).

C. pallidivittatus, Mall. Rather smaller and lighter than the last. Scutal stripes reddish, lateral pair usually with a blackish spot at posterior end, which sometimes extends forward and occupies half the stripe or more; postnotum rather broadly yellow at base; abdomen more or less extensively greenish-ochreous towards base; front femur scarcely darkened at tip and front tibia mainly pale; ♂ front tarsi without beard; *r-m* pale. Lateral lobes of ninth tergite longer and narrower than in *C. tentans*, anal point rather differently shaped (fig. 12*a*); styles shorter. Seaford, Sussex (*Verrall*); Wood Walton, Hunts. (*Rothschild*); Mitcham, Surrey (*F.W.E.*).

Group B.

(*Chironomus*, s.str.; *Einfeldia*, Kieff.; *Xenochironomus*, Kieff.)

♂. Ninth tergite not trilobed, anal point without dorsal flanges. Appendage 1 variable; 2 broad, straight or almost so, reaching well beyond end of coxite, and provided with numerous long curved hairs apically. Styles long, usually contracted on about the apical third, and nearly always with a close-set row of short stiff bristles on inner side at tip. Large to medium-sized species; frontal tubercles nearly always present; thorax usually pruinose. Middle femora with the apical projection broad.

This group may again be divided into three series, according to the form of appendage 1 of the hypopygium.

Series 1.

(*Chironomus*, s. str.; *Tendipes*, (Mg.) Kieff.; *Clinochironomus*, Kieff.; ? *Trichochironomus*, Goet.)

Appendage 1 strongly chitinised and quite bare. Cross-vein more or less conspicuously darkened. Body not entirely green.

This group includes most of the largest and most familiar members of the genus, but the characters separating many of the species are rather vague, and it is not always possible to be certain of the identity of even such a large insect as *Ch. plumosus.* The characters which have been used for specific differentiation are chiefly the leg ratio; the tarsal beard of the male (whether long, short, or absent); the thorax (whether light or dark, pruinose or not), and the shape of the upper basal appendage of the hypopygium (whether slender or slightly or considerably swollen at the tip). Almost every combination of these characters occurs, and the difficulty of assigning species limits is increased by the fact that many are very variable in colour according to locality and season as well as individually. Only two or three species are really well defined, the rest appearing to form an almost continuous series. Further study of all stages is needed before the relationships of this group can

be understood. Probably the number of distinct species is not so great as supposed by Kieffer and Goetghebuer. The following key is a provisional attempt to distinguish the British species, but is far from satisfactory; it is of necessity based chiefly on ♂ characters.

1. Body and legs almost entirely black (in mature examples) . . . . . 2.
   Body not entirely black, legs more or less pale, at least posterior tibiae . 4.
2. Halteres blackish; mesonotal hair black . . . . . *pilicornis*, Fabr.
   Knob of halteres and mesonotal hair pale . . . . . 3.
3. Larger; tarsal beard rather long . . . . . *anthracinus*, Zett.
   Smaller; tarsal beard very short or absent . . . . . *lugubris*, Zett.
4. L.R. 1·2–1·4; tarsal beard usually present even if short . . . . . 5.
   L.R. 1·5–1·7; tarsal beard absent . . . . . *dorsalis*, Mg.
5. Wing-length 6·5–8 mm.; A.R. 5; tarsal beard rather long . . *plumosus*, L.
   Wing-length 4–6 mm.; A.R. less than 5 . . . . . 6.
6. Frontal tubercles absent . . . . . *inermifrons*, Goet.
   Frontal tubercles very distinct . . . . . 7.
7. Appendage 1 of hypopygium rather long and slender . . . . . 8.
   Appendage 1 short, more or less swollen apically . . . . . 12.
8. Scutellum dark (♂♀); thorax heavily pruinose, with little trace of green even on shoulders . . . . . 9.
   Scutellum more or less pale, ground-colour of thorax greener . . . . 11.
9. Tarsal beard rather long, though not dense . . . . ? *annularius*, Goet.
   Tarsal beard short or absent . . . . . 10.
10. Wing-length 5–6 mm.; thoracic pruinescence without bluish tint; as seen from in front the dark median line extending from middle scutal stripe to scutellum appears of even width . . . . . ? *longistylus*, Goet.
    Wing-length 4–5 mm.; thoracic pruinescence with bluish tint, especially immediately in front of scutellum; dark median line less distinct, but tending to widen posteriorly . . . . . ? *longistylus*, var.
11. Anal point very broad; tarsal beard absent . . . . . *obtusidens*, Goet.
    Anal point not unusually broad; tarsal beard short . . . *cingulatus*, Mg.
12. Tarsal beard rather long . . . . . *aprilinus*, Mg.
    Tarsal beard short . . . . . ? *riparius*, Mg.

C. pilicornis, Fabr. (*niveipennis*, Fabr., *nec.* Kieff.; *niger*, Mg.; *tristis*, Wied.; *moerens*, Walk.; *dolens*, Walk.). All black, with only slight grey reflexions on thorax and towards posterior borders of abdominal segments. Legs blackish (lighter, as usual, in immature specimens), tarsal beard long and dense. Differs from all the other British species of the group in its blackish halteres and unusually short L.R. (0·95–1·0). Hypopygium almost as in *C. plumosus*. Locally common.

Fabricius' specimens of *C. niveipennis* in Copenhagen are this species.

C. anthracinus, Zett. (? *liebeli*, Kieff.; *bathophilus*, Kieff.). A large black species resembling the last, but halteres pale; legs more slender; tarsal beard less dense; L.R. 1·05–1·25. Lakes of England, Wales and Scotland.

C. sp. inc. A large black insect like the last two, but remarkable in having black pulvilli, all the other species having these structures white. L.R. about 1·25. A very distinct dark cloud over the cross-vein. Mayfield, Harold's Cross, Co. Dublin, xi.1927, 1 ♀ (*A. W. Stelfox*).

C. lugubris, Zett. Much smaller than the preceding; tarsal beard practically absent, and appendage 1 of hypopygium short and broad, as in *C. dorsalis*. Ilkley (*Grace*); Whernside, Yorks., and Black Mts., Hereford (*F.W.E.*).

C. plumosus, L. (*hebescens*, Walk.). The largest species of the group, and indeed of the family, but otherwise not very clearly defined. Frontal tubercles large, somewhat longer than in most other species; A.R. somewhat higher. Thorax heavily pruinose. Appendage 1 of hypopygium long, of uniform width, but not very slender. Common.

In the typical form the scutal stripes are dark grey, abdomen largely dark; var. *ferrugineovittatus*, Zett., has scutal stripes reddish-brown, ground-colour of thorax and abdomen lighter; var. *prasinus*, Mg., has the abdomen green, with small dark dorsal spots.

C. inermifrons, Goet. Differs from all the other British species of this group in lacking the frontal tubercles, also (in the three specimens before me) in having no trace of emargination on the front of the pronotum. Body and legs dark; tarsal beard very short; L.R. about 1·4. Bonawe, Argyll (*Waterston*).

C. annularius (De G.) Goet. As understood by Goetghebuer this appears to be a rather smaller and darker form of *C. plumosus*, with appendage 1 of hypopygium shorter and less stout, somewhat curved down at tip; L.R. about 1·3. The specimens which I refer with doubt to *C. annularius*, Goet., are probably only dark examples of *C. cingulatus*, but I have a note that De Geer's type in Stockholm is a male *C. plumosus* in good condition.

C. longistylus, Goet. If correctly identified here, this scarcely differs from the last except in having the tarsal beard short or absent. Common, chiefly inland.

A small variety (?), differing as indicated in the key, is common on coasts: Arran, Hants., S. Devon.

C. cingulatus, Mg. (? *nemoralis*, Zett.). Similar to the last two (perhaps not specifically distinct) but paler, scutellum yellowish or greenish in both sexes. Tarsal beard usually short, but in some specimens (as Zetterstedt's type of *nemoralis*) rather longer. Common.

C. obtusidens, Goet. Rather well distinguished by the very broad anal point, but otherwise quite similar to *C. cingulatus*. Ilkley (*Grace*).

C. aprilinus (Mg.) Goet. (*salinarius*, Kieff.; ? *hirtimanus*, Kieff.). Differs from *C. cingulatus* and related species chiefly in the shape of appendage 1 of the hypopygium, which is short and broad, but less strongly chitinised than in *C. dorsalis*; also in the longer tarsal beard. Common, especially on coasts.

C. riparius (Mg.) Goet. (*thummi*, Kieff.). Similar to the last, but tarsal beard quite short (though usually distinguishable); appendage 1 blackened. Scutal stripes usually black; pruinescence of thorax rather less than in the last few species. Common.

C. dorsalis, Mg. Hypopygium with appendage 1 short, broadened apically and blackened, as in *C. riparius*; differs from that species and also from all others of the group in the somewhat higher L.R., which is at least 1·5, but as usual is somewhat variable, and may reach 1·7. No trace of tarsal beard. Front tibia more or less darkened at base. First two segments of front tarsi usually more or less pale, darkened apically. Abdomen greenish or yellowish with dark bands on segments, variable in width. Common.

The typical form has the scutal stripes light to dark brownish and somewhat shining; they may, however, be quite black, and sometimes (var. *venustus*, Staeg.) the whole scutum, including the stripes, is more pruinose. Sometimes the front tibia is more extensively dark than usual, or even entirely blackish (var. *viridicollis*, v.d.W.).

Series 2.

(*Einfeldia*, Thienemann, *in litt.* ?)

Appendage 1 broad and pubescent on basal half or more, ending in a bare chitinised hook. Cross-vein not obviously darkened.

I place three species here for convenience only; they do not seem to be closely related, in spite of the similarity in form of the ♂ appendages. I have been unable to trace any description of the genus *Einfeldia*, but Kieffer has described a species *Einfeldia pectoralis* which is apparently very similar to *C. longipes*, and Thienemann sent me specimens of *C. dissidens* labelled "*Einfeldia insolita*, Kieff." The name *Einfeldia* would seem therefore to apply to this group.

C. longipes, Staeg. (*becquaerti*, Goet.). Thorax with ground-colour green; scutal stripes reddish; postnotum and sternum blackish. Abdomen mainly blackish, green at base. Front femur and tibia entirely greenish, tarsus not much darkened. L.R. nearly 2. Frontal tubercles very small. Common.

The specimen in Meigen's collection labelled *dorsalis* is this species, but is probably not the type as the description agrees better with the species usually so determined.

C. dissidens, Walk. (*convectus*, Walk.). Head black, including palpi and antennae. A.R. nearly 3. Frontal tubercles well developed. Thorax shining black, with slight pruinescence, shoulders and pleurae in ♀ extensively yellowish. Abdomen black. Hypopygium (fig. 12*c*) with anal point moderately long and slender; styles somewhat curved, slightly tapering, not constricted apically, with the usual small bristles on inner side at tip; appendage 2 stout, nearly straight, tip enlarged dorsally but not laterally. Legs: front femora brownish with black tip; posterior femora blackish. Tibiae yellowish with base and tip black, front pair darker. Tarsi blackish, basal half of first segment yellowish-white; no beard; L.R. about 1·7. Wings slightly greyish; costa and radius whitish towards base; R_1, R_{4+5} and *r-m* dark; *fCu* a little beyond *r-m*. Halteres yellow. Wing-length 3–3·5 mm.

Rather common; holds its wings in a roof-like position in life.

C. paganus, Mg. (*latidens*, Goet.). Body all bright green, scutum dull; tips of tibiae and almost the whole of the tarsi dark. Palpi black. No frontal tubercles. Anal point very stout. The largest of the plain green species. Common.

Series 3.

(*Xenochironomus*, Kieff.)

Appendage 1 rudimentary, fleshy and pubescent. No frontal tubercles. Cross-vein more or less darkened, but not conspicuously so. Body all green.

Only one British species.

C. xenolabis, Kieff. (*rousseaui*, Goet.; ? *flavinervis*, Kieff.). A green species superficially resembling *C. paganus*, but rather smaller, and palpi pale at base; styles not narrowed apically. Front tarsi of ♂ normally with slight beard, but this is absent in small specimens. Richmond (*Gotch*); Mullion, Cornwall (*Marshall*); Biggleswade, Beds. (*F.W.E.*).

Group C.

(*Limnochironomus*, Kieff.)

Appendage 2 long, narrow, more or less arched ventrally, long curved hairs present only at the tip, which is somewhat enlarged. No frontal tubercles. Middle femora with the apical projection rather hook-like. Cross-vein not darkened.

C. notatus, Mg. (*nigrimanus* auct. *nec* Staeg.; *heterolabis*, Kieff.). Scutum rather shining, stripes generally red in ♂, black in ♀ (an unusual difference), sometimes black also in ♂; postnotum usually black, sometimes red in ♂; abdominal segments 1–5 clear green, 6–8 usually black. Front legs with tip of femur and whole tibia black, tarsus black except base of first segment. Appendage 2 with membranous dorsal expansion. Rather common.

C. pulsus, Walk. (*fuscicauda*, Kieff., 1920 and 1922*d*; *atrovittatus*, Kieff., 1922*c*). ♂. Thorax green, scutal stripes, postnotum and sternum black. Abdomen olive-green, darker apically. Hypopygium (fig. 12*d*) much like that of *C. nervosus*, but styles shorter and club of appendage 1 much broader, almost four times as broad as the stem. Legs light brownish, front femur and tibia with blackish tips, the tibia darkened; tarsi with slight beard, L.R. about 1·5. Widely distributed, but I have seen no ♀ of the typical form.

A variety (?) was very abundant at Correin Lochan, Arran, in May 1919. In this the body and legs of the ♂ are almost completely blackish, shoulders and pleurae green; ♀ almost all green, scutal stripes and postnotum reddish.

Var. *objectans*, Walk. (*dispessus*, Walk.; ? *truncatus*, Kieff.). Similar to the type, differing only in having the scutal stripes reddish, postnotum and sternum remaining black. I have seen only Walker's types.

C. nervosus, Staeg. (*brevitibialis*, Zett. *nec.* Goet.; *futilis*, Walk.; *goetghebueri*, Kieff.; *falciformis*, Kieff.). All green; scutal stripes and postnotum becoming reddish in dried specimens; front femora all green, tibia narrowly dark at tip; no definite tarsal beard. Styles much longer than in *C. notatus*; appendage 1 (fig. 12*e*) with slender curved stem, expanded at tip on outer side only; 2 very long and curved, without dorsal membrane, tip not or scarcely bilobed. Common.

A variety has the abdomen blackish apically. Rugby (*Austen*).

C. tritomus, Kieff.? Closely resembles the last, but appendage 1 (fig. 12*f*) less slender, almost straight, expanded almost equally on both sides at tip; 2 distinctly bilobed at tip (Kieffer says trilobed, but our specimens do not show the small median lobe). Slapton, S. Devon (*Verrall*); Llyn Gwynant, Carnarvon (*F.W.E.*).

C. lobiger, Kieff., 1921*d* (*miriforceps*, Kieff., 1924*c*; *brevitibialis*, Goet. *nec* Zett.). All green; tip of front femur slightly darkened, of tibia more distinctly so; first segment of front tarsus whitish, narrowly dark at tip, remaining segments all dark. Styles much shorter than in the other species, stout basally, narrowed apically; appendage 1 (fig. 12*g*) short, almost cylindrical, with a more or less distinct beak-like projection at tip and with 5–6 hairs, which are variable in arrangement, sometimes appearing in a regular oblique row, sometimes otherwise; appendage 2 shorter, less slender and less curved than in the other species, tip enlarged and more or less conspicuously bilobed. Common.

Two slightly different forms occur: a smaller (*lobiger*) with tarsal beard very short or absent, wings not distinctly milky, 3–3·5 mm. in length; and a larger (*miriforceps*) with tarsal beard moderately long, wings distinctly milky,

3·5–4 mm. in length, club of appendage 2 more strongly bilobed. The differences are indefinite.

Group D.

(*Cladopelma*, Kieff.; *Paracladopelma*, Harnisch.)

♂. Appendage 2 short, but broad, distinguishable in the dry specimen, densely pubescent but without long hairs; appendage 1 also short and broad, with rather dense pubescence and a few long hairs; styles long, slender, curved, without conspicuous row of short bristles on inner side at tip. No frontal tubercles.

C. camptolabis, Kieff., 1913*b* (? *faeroensis*, Kieff., 1915*c*; *laminatus*, Kieff., 1921*d*; ? *viridis* var. *albiforceps*, Kieff., 1921*d*; ?? *allolabis*, Kieff., 1916). Ground-colour light to dark greenish; scutum somewhat pruinose; scape, postnotum and sternum black; scutal stripes red or black, usually separate but sometimes almost confluent; abdominal segments 5–8 usually blackish, sometimes the whole abdomen darkened. Wing-length 2·5–2·8 mm. Matlock, Dovedale and Monsaldale, Derbyshire; Arthog, Merioneth; Three Bridges, Sussex (*Verrall*); Richmond (*Gotch*); Holker Moss, N. Lancs.; Windermere; Shrewsbury (*F.W.E.*); Newtown, N. Wales (*Ricardo*); Corrour, Inverness (*Grimshaw*).

In addition to the variation in colour noted above, there seems to be considerable variation in the shape of the basal appendages of the hypopygium (fig. 12*l*, *m*), but I do not think this is specific.

C. claripennis, Mall. (?) ♂. Body all black; thorax somewhat pruinose except on scutal stripes, which are shining; legs blackish, tibiae scarcely lighter. Size somewhat larger than *C. camptolabis*, wing-length 3·2 mm.; styles slightly narrowed at tip (fig. 12*n*). Windermere (*F.W.E.*).

Another specimen, from Skirwith, Cumberland (*Britten*) is more pruinose (even on scutal stripes), posterior tibiae and bases of all tarsi lighter.

I have seen a specimen of this species from Iceland which is in all respects similar to the Windermere examples. It may not be specifically distinct from the last.

Group E.

(*Cryptochironomus*, Kieff.)

♂. Appendage 2 very small, not distinguishable in the dry specimen, usually discernible in the mount as a small pubescent pad, but often entirely absent. Body usually mainly or all green. Cross-vein not darkened. Middle femora with the apical projection more or less hook-like.

I include here the species referred by Goetghebuer to *Harnischia*; it seems very doubtful whether he was correct in doing so, as Kieffer described *H. fuscimanus* as having a trilobed ninth tergite, which is not the case in *simplex* or any of the other species known to Goetghebuer. We have about 24 species of the group, which may be arranged in four series, as follows :—

1.	Frontal tubercles rather large	Series 1.
	Frontal tubercles absent or very small	2.
2.	Tarsi definitely black and white	Series 2.
	Tarsi not definitely black and white	3.
3.	Front tibiae greenish with dark tip	Series 3.
	Front tibiae (usually also the tarsi) all blackish	Series 4.

Series 1.

(*Cryptochironomus*, s. str.)

Frontal tubercles present and rather large. Tarsi mainly dark, or at least not definitely black and white. Wing-length 3·5–5 mm. ♂ styles rather short and thick; appendage 1 very short but broad, pubescent, visible in the dry specimen.

Three or four British species, including the genotype of *Cryptochironomus*.

C. psittacinus, Mg. (*armillatus*, Staeg.). Scutal stripes and postnotum black, also the whole of the front tibiae and tarsi; abdomen dark green. Front tarsi of ♂ with long beard, L.R. about 1·1. Levenshulme, Manchester (*Britten*).

C. albofasciatus, Staeg. (? *biannulatus*, Goet.). Green; front tibia greenish with dark tip; front tarsi with segments 1 and 2 obscure whitish, tips blackish, 3 brownish with blackish tip, 4 and 5 black. Tarsal beard rather short but distinct. Oxford (*Hamm*); Radwell, Herts.; Quy, Cambs.; Sowley Pond, Hants. (*F.W.E.*).

C. supplicans, Mg. (*defectus*, Kieff.; *chlorolobus*, Kieff.). Similar to the last, but front tarsi almost entirely blackish, first segment only a little paler at base; beard distinct. Slapton, S. Devon (*Verrall*); Llyn Gwynant, Carnarvon (*F.W.E.*); Aldeburgh, Suffolk (*Jenkinson*).

C. obreptans, Walk. (? *imberbipes*, Kieff.). Walker's type is a ♀, differing from the last in having the first front tarsal segment gradually darkened to the tip. A similar ♂ from Uxbridge (*F.W.E.*) further differs in having no tarsal beard, but the hypopygium is quite as in *C. supplicans*.

Series 2.

Frontal tubercles absent. Tarsi with contrasting bands of black and white. Body all green. Wing-length 3·5–5 mm. ♂ styles rather long; appendage 1 rod-like (but often hidden), not pubescent, with two or three terminal hairs. Front tarsi of ♂ bearded.

Three British species, all very distinct.

C. biannulatus, Staeg. (*malacus*, Walk.; *viridanus*, Ruthé, Goet.). Front tibia with tip narrowly black. Front tarsus: 1 white, with the terminal two-fifths black; 2 white, with narrow black tip; 3–5 black; beard slight. Oxford (*Hamm*); Cardington, Beds. (*F.W.E.*).

C. longiforceps, Kieff. (*lhoneuxi*, Goet.). Smaller than the last, and hypopygium differs. Front tibia with distal third to two-thirds black; tarsus as in *C. biannulatus*, but beard longer. Staines (*Austen*); Putney (*F.W.E.*).

C. vitiosus, Goet. Front tibia of ♂ with about the distal fourth, of ♀ one-third to two-thirds black. Front tarsus of ♂ with rather long beard, segments 1 and 2 all white, 3 white with the tip more or less broadly black, 4 and 5 all black; in ♀ the third tarsal segment is nearly always entirely black, also the tip of the second. Putney, Mx.; Cardington, Beds.; Wicken, Cambs.; Castle Howard, Yorks. (*F.W.E.*); Bonawe, Argyll (*Waterston*).

Series 3.

(*Parachironomus*, Lenz, 1921, Harnisch.)

Frontal tubercles absent. Front tibiae greenish with dark tip. Front tarsi dark, first segment often more or less whitish towards base. Male styles long; appendage 1 usually distinct, rod-like, with two or three short hairs at tip. Front tarsi of ♂ without beard, L.R. 1·5–1·7.

C. monochromus (v.d.W.), Goet. (*bacilliger*, Kieff.). All green; legs pale, first front tarsal segment gradually and slightly darkened from base to tip. Male styles very long and slender, hairy only near the base and on the swollen tip; anal point and appendage also very long and very slender. Slapton, S. Devon (*Verrall*); Beesands, S. Devon and Letchworth, Herts. (*F.W.E.*); Oxford (*Hamm*).

C. claviforceps, sp. n. ♂. All green; front tarsi with the first segment whitish, tip rather narrowly dark, remaining segments blackish. Wings not distinctly milky, *fCu* scarcely beyond base of *Rs*. A.R. not quite 3. Styles much swollen apically, but not so long as in *C. monochromus*; anal point and appendage also shorter (fig. 12*k*). Wing-length 2·8 mm. Letchworth, Herts. (*F.W.E.*).

C. varus, Goet. ♂. Green; scape and hypopygium dark, almost black; front tarsi mainly blackish. Wings rather strongly milky. Styles stout, tapering apically, with dorsal keel; appendage rather long, enlarged at tip. Wing-length 4–4·5 mm. Wood Walton, Hunts. (*Rothschild*); Manchester (*Britten*); Stockport, Cheshire (*Miss A. M. Evans*).

The specimens from the last locality were reared from larvae found in the body of a water-snail (*Limnaea peregra*); possibly the predaceous larvae found by Barnard (1912) in Trafalgar Square belonged to this or a nearly related species.

C. parilis, Walk. (*irretitus* Walk., ♀; *mucronatus*, Goet.). Similar to the last, but smaller; scape and hypopygium pale; first front tarsal segment nearly all whitish; styles rather more slender. Widely distributed.

C. digitalis, sp. n. ♂. Greenish; scape, postnotum and sternum black; scutal stripes brownish; abdomen with incisures and last few segments more or less darkened; front tarsus almost all dark; wings milky. Styles long and slender, almost straight and of almost uniform thickness throughout; appendage reaching well beyond end of coxite, scarcely enlarged at tip (fig. 12*h*). A.R. at least 3. Wing-length 3·5 mm. Oxford (*Hamm*); Richmond, Surrey (*Gotch*); Dreghorn, Ayrshire (*F.W.E.*); Kincraig (*Grimshaw*).

C. pseudotener, Goet. (? *incertus*, Walk., ♀). All green, scutal stripes and postnotum yellowish; front tibia somewhat darkened, also last few segments of abdomen. Styles slightly constricted in middle; appendages scarcely reaching beyond end of coxite, but distinct. Radwell, Herts. (*F.W.E.*).

C. falcatus, Kieff. (? *gracilior*, Kieff.; *arcuatus*, Goet.). ♂. All green; first segment of front tarsi whitish with blackish tip, second also more or less distinctly whitish towards base. Styles long, almost cylindrical, curved; appendage short, not reaching beyond end of coxite. Ormesby, Norfolk (*Verrall*); Beesands, S. Devon; Sowley, Hants.; Mitcham, Surrey; Shefford, Beds.; Windermere (*F.W.E.*).

Series 4.

(*Harnischia*, Goet., ? *nec* Kieff.)

Frontal tubercles absent or very small. Front tibiae entirely blackish, usually also the front tarsi. Appendages of hypopygium short or absent. Scutum usually striped. Front tarsi of ♂ without beard.

C. denticulatus, Goet. ♂. Thorax yellowish-green; scutal stripes, etc., reddish; abdomen green, darkened apically. Tips of front femora rather broadly blackish; chitinised hooks at tips of posterior femora black and very conspicuous. Styles rather short and thick; appendage 1 rather broad,

pubescent. Wings not milky. Richmond (*Gotch*); Ilkley (*Grace*); Temple Sowerby, Westmorland (*F.W.E.*).

C. rostratus, Kieff. (*virtunensis*, Goet.). Similar to the last, but tip of front femur scarcely darkened, and apical hooks of posterior femora pale and transparent as usual. Biggleswade, Beds. (*F.W.E.*); Leeds (*Hincks*).

C. vulneratus, Zett. (*nigrimanus*, Staeg., type; *longicauda*, Goet.). The largest species of the group; body 7–8 mm., wing 5 mm. long. Green; scutal stripes and postnotum reddish; abdomen more or less darkened apically; wings strongly milky; front tarsi all black. A.R. 4 or more. Styles rather long, stoutest in middle, with longitudinal dorsal keel; appendages very small. Three Bridges, Sussex (*Verrall*); Lewis, Hebrides (*Lamb*); Windermere (*F.W.E.*).

Variety (?). Thorax and abdomen all green. Biggleswade, Beds. (*F.W.E.*).

C. atriforceps, Goet. Similar to the last, especially in hypopygium, but much smaller; A.R. rather less than 3; tip of front femur more conspicuously darkened; wings not milky. Dolgelley (*Verrall*); Ilkley (*Grace*); Milnthorpe and Temple Sowerby, Westmorland (*F.W.E.*).

C. nigronitens, sp. n. ♂. Head and thorax shining black. Palpi black. Antennal plume mainly dark, but lighter towards tip, A.R. about 3. Abdomen dark olive-green, hypopygium (fig. 12*i*) lighter. Ninth tergite much swollen, almost square-ended as seen in side view, and point short. Styles rather long, thickened on about the basal half. Appendage 1 short, but reaching slightly beyond end of coxite, with three terminal hairs; 2 entirely absent. Front legs entirely blackish, L.R. about 1·4; posterior legs dark olive-green. Wings milk-white, all veins white, even including costa. Halteres greenish, stem darker. Wing-length 2·5 mm. Levenshulme, Manchester, 27.vii.1929 (*Britten*), also one old damaged specimen in the British Museum collection, determined by Walker as *C. glabricollis*, Mg.

This is strikingly distinct in colour from all other members of the subgenus, yet it is structurally a typical member of this group.

C. tener, Kieff. Green; scape black; scutal stripes reddish, not distinctly shining; postnotum black, narrowly green at base; legs greenish, front tarsi all black; wings white, all veins pale. Hypopygium very much as in the last, style swollen on basal half. Radwell, Herts. (*F.W.E.*).

C. cinctellus, Goet. (?). Olive-green, abdomen darker than ground-colour of thorax; scape, postnotum and sternum black; scutal stripes reddish-brown; abdominal incisures blackish. Front tibia and tarsus all dark blackish-green. Hypopygium almost exactly as in *C. falcatus*. Harlesden, Mx. (*Austen*).

This may not be correctly named as the styles are not nearly so stout as shown in Goetghebuer's figure, which, however, may not be accurate.

C. viridulus (L.) Goet. (?? *bipunctatus*, Kieff.; ? *monotomus*, Kieff.; ? *tricolor*, Kieff.). ♂. Green; scape, palpi, postnotum (except base) and sternum black; scutal stripes red or black, or (more usually) the middle stripe black and the laterals red, sometimes the lateral stripes are red, with a black spot at each end; last few segments of abdomen usually black; front tarsus all black, L.R. about 1·5–1·7; wings milky. Hypopygium with practically no trace of appendages, styles slightly thickened on basal half. Common.

C. pseudosimplex, Goet. (? *lacustris*, Hal.). Similar to the last, but first front tarsal segment broadly pale towards base, L.R. 1·8–1·9; scutal stripes all reddish; scape reddish (though postnotum is black); styles of more uniform thickness throughout. Windermere (*Verrall, F.W.E.*).

In most respects this answers to Haliday's description of *C. lacustris*; he stated that the ♀ had 7-segmented antennae, but this was probably a mistake. The type is lost.

C. virescens (Mg.) Goet. ♂. Resembles *C. viridulus*, but postnotum and sternum as well as scutal stripes light reddish (scape black); first front tarsal segment rather narrowly whitish at base; abdomen not or scarcely darkened at tip. The hypopygium of our specimens (fig. 12*j*) does not quite agree with Goetghebuer's figure. Styles somewhat bent in middle, terminal half tapering; appendage 1 just distinguishable. Gormire, Yorks.; Quy Fen, Cambs.; Epping Forest (*F.W.E.*); also in Mr. Collin's collection.

Subgenus **Glyptotendipes**, Kieff.

(? *Phytochironomus*, Kieff.)

Antennae of ♂ with 12 segments, A.R. 3 or more; of ♀ with 7 segments. Frontal tubercles absent or very small. Pronotum small, divided in middle, closely applied to the mesonotum and not visible from above. In the typical species, abdominal segments 2–5 have in both sexes a raquet-shaped impressed area at the base mid-dorsally, and tergite 6 has a similar but more elongate impression. ♂ styles only moderately long, without stiff bristles on inner side at tip; appendage 1 short, curved, bare; 2 stout, with long curved hairs apically, but reaching only a short distance beyond base of style. Tibial combs large, each with a short spur. Pulvilli large. R_{2+3} ending well beyond R_1 (Plate XIX, fig. 10); *fCu* below *r-m*.

This group was originally segregated by Kieffer on account of the peculiar impressions of the abdominal tergites. It has since been found that certain other species, though with impressions of the abdomen feebly indicated or absent, have a similar hypopygium and agree in larval habits and pupal structure with *Glyptotendipes*, and further that all these species have a reduced pronotum. The form of the pronotum would seem therefore to provide the best distinction from *Chironomus*, s. str. So far as I can judge from the descriptions Kieffer's name *Phytochironomus* seems to refer to species of this subgenus without abdominal impressions; I think Goetghebuer is wrong in applying it to *Ch. paganus*, Mg., and related species. We have about seven species in Britain; distinguishable as follows :—

1. Abdominal impressions very distinct; *r-m* darkened . . . . . 2.
   Abdominal impressions feebly indicated; *r-m* not darkened; halteres whitish . . . . . 5.
2. Second segment of front tarsi a little longer than third; no trace of frontal tubercles . . . . . 3.
   Second segment of front tarsi not longer than third; small frontal tubercles present . . . . . 4.
3. Blackish, legs dark, thorax heavily pruinose . . . . . *glaucus*, Mg.
   Brown; legs pale; all veins darkened . . . . . *gripekoveni*, Kieff.
4. Second and third front tarsal segments equal in length . . *paripes*, sp. n.
   Second front tarsal segment shorter than third . . . . . *barbipes*, Staeg.
5. Body and legs blackish . . . . . *foliicola*, Kieff.
   At least ground-colour of thorax and femora green . . . . . 6.
6. Scutal stripes black, abdomen blackish . . . . . *mancunianus*, sp. n.
   Colour otherwise . . . . . 7.
7. Scutal stripes reddish, end of abdomen dark . . . . . *imbecillis*, Walk.
   Thorax and abdomen all green . . . . . *viridis*, Mcq.

C. (G.) glaucus, Mg. (*obscuripes*, Mg.; *pallens*, Goet., *nec* Mg.; *annularius*, Verr. Coll., *nec* De G.; ? *abstrusus*, Kieff.). Integument blackish, but thorax heavily pruinose with light grey, even on the scutal stripes. Impressions of abdominal tergites very distinct, that on tergite 6 narrow and more than half as long as the segment. Legs very dark, except the front femora, which are reddish-brown with tip darker. Second segment of front tarsi a little longer than third; beard moderate to rather long. Wings greyish, with scarcely any milky tinge; anterior veins and *r-m* very dark, but cubital fork scarcely darkened. Knob of halteres dark grey. No trace of frontal tubercles. Size variable, body of ♂ 6–9 mm. long. Common.

Meigen's description of *C. glaucus* leaves little room for doubt that it refers to the present species, although I have not seen the type. His types of *C. obscuripes* in Paris agree with our material in regard to the dark legs, absence of frontal tubercles, etc. According to the description the front tarsi of the male have no beard, but Meigen's specimens were probably rubbed; in any case the beard is not so conspicuous as in some other species. Meigen is also inaccurate in describing the legs as all dark; the front femora of his type are reddish with dark tip, as in our specimens. *C. pallens*, Mg., is also a *Glyptotendipes* related to the present species, but the type ♀ has distinct frontal tubercles, and differs, as stated by Meigen, in having pale instead of dark antennae. According to the type *C. annularius*, De G., is a true *Chironomus* near *C. plumosus*, L. *C. flavimanus*, Mg., is similar to *C. glaucus*, but has the scutal stripes dark reddish-brown and wings distinctly milky; front tarsus and end of abdomen of type lost.

C. (G.) paripes, sp. n. Blackish, including antennae and legs, even the front femora scarcely lighter. A.R. about 4; ♀ antennae 7-segmented as usual. Frontal tubercles present but very small. Thorax heavily dusted with grey, but stripes less so than remainder of scutum, and therefore appearing blacker than in *C. glaucus*. Abdomen when seen from behind with only slight grey dusting towards posterior margins of tergites 1–5 and over the whole of 6–8. Impressions distinct, but smaller and more oval than in *C. glaucus*, that on tergite 6 less than half as long as the segment. Hypopygium much as in related species. Segments 2 and 3 of front tarsus equal in length, beard rather long and conspicuous; L.R. about 1·25. Wings with much more distinct milky tinge than in *C. glaucus*; anterior veins and *r-m* strongly darkened; *M* beyond the cross-vein entirely pale, as in *Cu*. Knob of halteres more or less darkened, as in *C. glaucus*. Wing-length about 5 mm., body of ♂ about 8–9 mm. Whernside Tarns, Yorks. (*F.W.E.*); Sharpham Moss, Somerset (*Audcent*); Fiskerton, Notts. (*Carr*).

C. (G.) barbipes, Staeg. (? *heteropus*, Kieff.). Very similar to the last, but second segment of front tarsi distinctly shorter than the third, third and fourth subequal in length; beard dense, conspicuous even on fourth tarsal segment; halteres less distinctly darkened. Barmouth (*Yerbury*).

C. (G.) gripekoveni, Kieff., 1913*a*. Body mostly brownish, thorax heavily pruinose; scutal stripes fairly distinct, middle one usually reddish-brown, lateral pair darker, sometimes all three blackish. Legs entirely pale. Wing-veins all about equally dark, distinctly seamed with grey when viewed obliquely; a grey streak in cell R_5 at tip. Halteres pale. Abdominal impressions very distinct. Common.

C. (G.) foliicola, Kieff. Body blackish; thorax moderately dusted with grey, except on scutal stripes, which are somewhat shining. No frontal tubercles. A.R. about 3. Abdomen with very little trace of grey dusting, except

towards hind margins of segments 6–8. Hypopygium (fig. 13*b*) as figured by Goetghebuer for *C.* (*G.*) *annulimanus*. Mid-dorsal impressions of tergites scarcely indicated, very much less distinct than in the four preceding species. Legs of ♂ all black, front tarsi with short beard, L.R. about 1·4; femora and tibiae of ♀ brownish with black tips, tarsi black. Wings with the veins rather pale, even costa and radius very little darkened, *r-m* pale. Halteres whitish. Wing-length 4 mm.; body of ♂ 6 mm. Ickleford and Offley, Herts. (*F.W.E.*); Manchester and Reddish, Lancs.; Bollin Valley, Cheshire (*Britten*).

C. foliicola was described by Kieffer (1918) as a variety of *C. niveipennis*, Fabr., but the latter as redescribed by Zetterstedt and as shown by Fabricius' type seems to be *Ch. pilicornis*, Fabr. Our specimens differ from Kieffer's description in the shorter tarsal beard, but this is probably a variable character.

C. (G.) mancunianus, sp. n. ♂. Head green; palpi and antennae black. A. R. nearly 4. No frontal tubercles. Thorax with ground-colour rather dark green; scutal stripes, postnotum and sternum black; scutum somewhat grey-dusted. Abdomen slender, very dark green, hind margins of tergites almost black; venter lighter. Impressions of tergites 3–6 feebly indicated. Hypopygium (fig. 13*a*) almost as in *C. viridis* (Mcq.) Goet. Legs with the femora greenish, tips darker; tibiae and tarsi in a fully matured specimen dark coloured, almost black. Front tarsi with long beard, longest hairs quite five times tibial diameter; segments 2 and 3 of front tarsi about equal in length. Wings as in *C. viridis*; anterior veins and *r-m* only slightly darkened; *Cu* pale. Halteres pale. Wing-length 3·7 mm.; body 6 mm. Levenshulme, Manchester, 13.vi.1927, 4 ♂♂ (*Britten*).

This is perhaps only an exceptionally dark variety of *C. viridis*. It does not appear to be included in Kieffer's key to the palaearctic species.

C. (G.) viridis (Mcq.) Goet. (? *candidus*, Kieff.). Green; scutal stripes scarcely indicated; abdomen scarcely darkened apically. Thorax grey-dusted all over. Impressions of abdominal tergites 3–6 only very faintly indicated, but pronotum reduced as in other species of the subgenus, and hypopygium similarly constructed. Frontal tubercles absent. According to Goetghebuer the tarsi of the ♂ have no beard, but in our specimens the beard is quite distinct; the hypopygial structure agrees with Goetghebuer's figure, except that the upper basal appendage is somewhat stouter. Cardington, Beds. ($F.W.E_1$).

Kieffer and Goetghebuer describe the ♀ antennae as 6-segmented, but this is probably a mistake. The single ♀ I have examined has segments 2 and 3 distinctly separate, as in other members of the subgenus.

C. (G.) imbecillis, Walk. (? *severini*, Goet.; ? *fulvofasciatus*, Kieff.). Green; scape, scutal stripes and postnotum reddish; segments 6–8 of abdomen blackish; front tarsi of ♂ with longish beard. The hypopygium of the specimens I have examined is intermediate between *C. viridis* and *C. severini* as figured by Goetghebuer; it is very doubtful whether these three are distinct species. Staines, Middlesex (*Austen*).

Subgenus **Endochironomus**, Kieff.

Antennae of ♂ with 14 segments (except in *rufipes*) of ♀ with 7 segments. No frontal tubercles. Pronotum moderately well developed and reaching up to anterior margin of scutum, but divided medially into two rounded lobes. Scutum without hump in middle. Abdominal tergites smooth. Male hypopygium with rather stout oval styles; appendage 2 generally with two long apical hairs. Posterior tibiae with large combs, each with a short spur, the one on the outer comb very small and difficult to detect, perhaps some-

times absent; the more distinct spur is ventral rather than internal in position. Pulvilli present, but sometimes rather small. Wings unmarked. R_{2+3} ending well beyond tip of R_1 (Plate XIX, fig. 11); *fCu* hardly beyond *r-m*.

We have seven British species, all of rather large size, and most of them with a shining black thorax. They have much general resemblance to the species of *Microtendipes*, but may be distinguished at once by the venation.

C. (E.) lepidus, Mg. (*notabilis*, Mcq.). Scape (♂) or the whole antennae (♀) yellowish. Thorax shining black. Abdomen (at least in ♂) green. Legs yellowish, front tibiae dark; tarsi not bearded. Wings greyish. Three Bridges, Sussex (*Verrall*); Epping (*F.W.E.*).

C. (E.) dispar, Mg. Antennae all black (♂) or dark (♀). Thorax shining black Abdomen blackish, tergites in ♂ broadly pale apically. Legs yellow, tarsi dark, outer half of front tibia blackish. Front tarsi of ♂ with moderate beard. Wings pale greyish. Epping (*F.W.E.*).

C. (E.) impar, Walk. (*involitans*, Walk.). Much like the last, but legs darker, brownish; front femora usually yellowish with dark tip; front tibiae light to dark brown or almost black, tip rather narrowly blackish; no tarsal beard. Abdomen darker, sometimes all black. Common. Although Walker's type ♂ and ♀ of *impar* belong to different species (the ♂ being *Prodiamesa*) I select this name for the species on account of the affinity it suggests with *dispar*.

C. (E.) intextus, Walk. (*coracellus*, Kieff.). Thorax shining black, occasionally with lighter pleural patch and indications of lighter ground-colour of scutum. Abdomen all black. Hypopygium quite different from the last two, especially in the form of appendage 1, which has a swollen base and hooked tip. Legs blackish. Widely distributed. Kieffer refers the species to *Microtendipes*, from which it differs in venation, pronotum and tibial spurs, these being quite as in *Endochironomus*. The hypopygium suggests the *Einfeldia* group of the subgenus *Chironomus*, another instance of the complicated manner in which all these subgenera are related.

C. (E.) tendens, Fabr. (*trichopus*, Walk.). ♂. Antennae and palpi blackish. Thorax light greenish ochreous. Abdomen green. Legs pale ochreous. Tarsal beard slight. ♀. Body entirely bright ochreous brown, without green colour even in life. Wings in both sexes greyish, without milky tinge. Locally common.

C. (E.) albipennis, Mg. (? *miki*, Kieff.). ♂. Antennae and palpi black. Thorax with green ground-colour; scutal stripes more or less indicated, usually light to dark brown, but sometimes black; postnotum and mesosternum dark brown to black. Abdomen green. Tarsal beard moderately long. ♀. Body practically all green. Legs pale greenish. Wings in both sexes with slight but distinct milky tinge. Common.

The form with black scutal stripes (*maritimus*, Kieff.) is the one most commonly met with in the north of England and Scotland. It is possibly a distinct species.

C. (E.) rufipes, L. Wings with a brown transverse band before the middle, darker towards costa, partly limited externally by *r-m*, but spreading out above to fill end of costal cell. Thorax shining black. Abdominal segment 1 yellow, 2 black, 3–6 yellow with black bands; no impressions on tergites. Legs mostly yellow, front tarsi darker, with long beard in ♂. Widely distributed but not common.

Although this differs from the other species of the subgenus in having only

12-segmented ♂ antennae, the form of the pronotum is similar to that of the other species, and *C. rufipes* seems more in place here than in the subgenus *Glyptotendipes*, to which Goetghebuer referred it.

Subgenus **Stenochironomus**, Kieff.

Antennae of ♂ with 14 segments, of ♀ with 6 segments. No frontal tubercles. Pronotum much reduced, not nearly reaching anterior margin of scutum, which is more prominent than usual and almost pointed. Male hypopygium with styles very long; appendage 2 also very long, strap-like, pubescent at base, with a few long hairs towards tip and a terminal spine. Tibial combs each with a short spur. Pulvilli well developed. Wings with one or two dark transverse bands. R_{2+3} running very close to R_1, almost fused with it.

A small group with only two British species; perhaps one or two others in Europe, but these are not very well distinguished.

C. (S.) gibbus, Fabr. (*flexilis* auct., *nec* Linn.; *fasciatus*, Geoffr., Kieff.; ? *occultus*, Kieff., 1924*c*). Green, scutum with yellowish stripes, postnotum brown; abdomen dark apically. Femora dark at tips, front pair broadly so; hind tibiae all dark. Wings with a broad dark grey median band, which in ♀ extends basally some distance in anal cell Nowhere common, but widely spread. New Forest (*Lamb*); Richmond (*Gotch*); Staines (*Austen*); Rydal (*Verrall*); Killarney (*F.W.E.*).

C. (S.) fascipennis, Zett. Green; thorax without distinct markings; abdomen more or less black on segment 6. Femora all narrowly dark at tips; front tibiae broadly dark at base and narrowly at tip; hind tibiae pale in middle. Wings with a narrower and lighter grey median band; a second broader band over the tip. Newmarket (*Collin*); Watford (*F.W.E.*).

Subgenus **Paratendipes,** Kieff.

Antennae of ♂ with 14 segments, A.R. more than 1; of ♀ with 7 (sometimes 6, according to Kieffer). No frontal tubercles. Pronotum fairly well developed, not distinctly divided in middle. Hypopygium with appendage 1 hook-like, 2 normal, 2*a* present. Front tibia with a very short spur. Tibial combs normal, fused, each with a very short spur. No pulvilli. Wings bare; squama with or without fringe.

This was one of the first groups to be separated from *Chironomus* by Kieffer, on account of the absence of pulvilli. According to Bause and Gripekoven the larvae are intermediate between *Chironomus* and *Tanytarsus*; this is confirmed by the adults, which resemble *Chironomus* in most respects although the hypopygium approaches the structure of *Tanytarsus*, and in one species the squama is bare.

We have only two British species, one of which, however, has a rather distinct variety which has often been treated as a separate species.

C. (P.) albimanus, Mg. Body all black, thorax strongly shining; legs black, except that the first segment of the front tarsi is normally entirely white, and the four posterior tibiae are more or less yellowish, with both ends darkened; tibiae often lighter in ♀ than in ♂. A.R. about 1·3–1·5. Antennae of ♀ 7-segmented, 4–6 with short necks, 7 slender, nearly twice as long as 6. Hypopygium small; anal point moderately long and slender; styles somewhat broadened in middle, with a number of short stiff bristles on inner side at tip; appendage 1 broad basally, rather suddenly narrowed towards tip;

2 with rather short curved hairs; 2*a* about half as long as 2, hairy. L.R. about 1·4. R_{4+5} ending above tip of M; R_{2+3} ending only a short distance beyond R_1 (about one-fourth of the distance between R_1 and R_{4+5}); *fCu* a short distance beyond *r-m*. Squama with a short but complete fringe. Wing-length 3–3·5 mm. Common.

Var. *plebeius*, Mg. (*fuscimanus*, Kieff.). Differs only in having the first front tarsal segment yellowish-white on the basal third to half, the rest gradually darkened; the hypopygia appear to me identical. This variety might easily be confused with *C. dissidens*, Walk., but apart from the structural differences *P. albimanus* differs in its attitude in repose, the wings being held slightly separated. The variety is rather less common than the type.

C. (P.) nudisquama, sp. n. Body black, with shining thorax as in the last species; legs entirely dark, including the whole of the front tarsi. A.R. about 1·25. Antenna of ♀ 7-segmented, 4–6 without distinct necks, 7 not more slender, hardly 1·5 times as long as 6. Hypopygium much as in *P. albimanus*, but styles more slender, finger-like, with fewer short stiff bristles at tip; appendage 2 with longer hairs; 2*a* shorter (fig. 13*h*). L.R. about 1·3. R_{4+5} ending distinctly before level of tip of M; R_{2+3} ending only just before midway between R_1 and R_{4+5}; *fCu* rather further beyond *r-m*. Squama quite bare. Wing-length barely 2 mm.

Letchworth, Herts., 1 ♀ reared from *Sphagnum* in boggy place (*F.W.E.*). Baldock, Herts., 1 ♂ (*F.W.E.*). Parknasilla, S.W. Ireland, 1 ♂ in Dublin Museum (*Yerbury*). This is an interesting species connecting *Paratendipes* with *Lauterborniella*.

Subgenus **Kribioxenus,** Kieff.

Antennae of ♂ 14-segmented, A.R. only about 0·3; of ♀ 7-segmented. Pronotum much reduced, not visible from above. Hypopygium with a large conical projection on ninth tergite, behind anal point; appendage 1 pubescent, 2 of the usual form, 2*a* absent. Front tibia with longish, slender spur; combs of posterior tibiae subequal, almost fused, each with a short spur. Pulvilli scarcely distinguishable. Squama without fringe. R_{4+5} ending slightly before level of tip of M; *fCu* well beyond *r-m*.

C. (K.) brayi, Goet. Green; scape, scutal stripes and postnotum yellow or reddish; legs pale, front femora and tibiae rather broadly dark at tips. L.R. 1·4. Wing-length barely 2 mm. Richmond, Surrey (*Gotch*); Llyn Gwynant, Carnarvon (*F.W.E.*).

Goetghebuer is mistaken in saying that there is only one spur on the posterior tibiae.

Subgenus **Microtendipes,** Kieff.

Antennae of ♂ 14-segmented, A.R. usually about 2; of ♀ with 7 segments. No frontal tubercles. Pronotum much reduced, overhung by scutum and divided in middle. ♂ styles usually somewhat oval, appendage 2 usually without long apical hair. Front tibia without spur; posterior tibial combs very unequal, posterior comb of middle tibia and external comb of hind tibia each with longish spur, other combs larger and unarmed. Pulvilli rather small. Wings unmarked. R_{2+3} closely approximated to tip of R_1 (Plate XIX, fig. 12); *fCu* below or slightly beyond base of *Rs*. Rather large species, wing-length 4–5 mm.

About nine British species, some of which are not very clearly defined; two or three are rather variable. *C. nitidus* shows an approach to the subgenus *Endochironomus*, *C. hibernicus* to *Stenochironomus* and *C. fuscipennis* to

Polypedilum; these three species seem to show clearly that the groups named cannot be treated as separate genera.

1. Femora and tibiae all black, tarsi white . . . . . *tarsalis*, Walk.
   Legs otherwise coloured . . . . . 2.
2. At least front tibia darkened at base . . . . . 3.
   All tibiae yellow, not darkened at base . . . . . 8.
3. Front femora blackish on apical third or more . . . . . 4.
   Front femora yellowish, black only at tip . . . . . 6.
4. Abdominal segments 1–5 clear green . . . . . *pedellus*, De G.
   Abdominal segments 1–5 olive-green to black . . . . . 5.
5. Appendage 2 of hypopygium normal, short and hairy . . . . *chloris*, Mg.
   Appendage 2 very long and nearly bare . . . . . *hibernicus*, sp. n.
6. Thorax shining, stripes reddish . . . . . 7.
   Thorax strongly pruinescent except on stripes . . . . *confinis*, Mg.
7. Front tibia largely yellowish . . . . . *diffinis*, sp. n.
   Front tibia all black . . . . . *britteni*, sp. n.
8. Legs and halteres all yellow, abdomen all black . . . . . *nitidus*, Mg.
   Front femur partly black, halteres black, abdomen black at tip only *fuscipennis*, Mg.

C. (M.) tarsalis, Walk. (*formosus*, Goet.). Thorax shining black, abdominal segments 1–5 green, 6–9 black. Scape orange. Femora and tibiae black, tarsi white, last one or two segments darkened. No tarsal beard; venation as in *C. pedellus*. Hypopygium with basal appendages very short. Widely distributed, but local; in woods.

C. (M.) pedellus, De G. Thorax usually with dark brown ground-colour, stripes shining black, more or less contiguous; sometimes whole thorax of ♂ shining black; scutellum always dark; no pruinescence. Abdomen with segments 1–5 clear green, 6–9 black. Front femur blackish on about the apical half; front tibia broadly dark at base and more narrowly at tip; front tarsus more or less pale, tips of first two or three segments darkened; no beard; L.R. about 1·25. R_{2+3} actually in contact with tip of R_1 and continued for a short distance along costa. Hypopygium with long anal point; appendage 1 (fig. 13*c*) somewhat curved, broad and rounded at tip, with about 7–10 hairs in middle; 2 moderately short and stout. Very common.

Var. *lividus*, Mg. (? *brachysandalum*, Kieff.; *cinereiventris*, Goet.). Front tibia entirely black, otherwise as in the type. King's Walden, Herts., and Gormire, Yorks. (*F.W.E.*).

C. (M.) chloris, Mg. (*discrepans*, Walk.; ? *abbreviatus*, Kieff.). Thorax shining black, scutal stripes rarely indistinctly separate. Abdomen with segments 1–5 olive-green, lighter apically; sometimes the whole abdomen darker, or even entirely black (var. *lugubris*, Kieff., 1921*d*), though segments 1–5 are usually somewhat lighter than 6–9. Legs darker than in *C. pedellus*, front tibia usually all black; front tarsi with short or moderate beard; L.R. 1·05–1·25, averaging less in the darker specimens. Venation and hypopygium as in *C. pedellus*. Common.

Kieffer's *C. abbreviatus* (the genotype of *Microtendipes*) may have been described from immature examples of this species; in any case it is evidently nearly related.

C. (M.) diffinis, sp. n. ♂. Scape reddish, antennal plume dark except apically, A.R. about 1·8. Mouth-parts black. Thorax without trace of pruinescence; ground-colour of scutum light brownish, stripes reddish; scutel-

Fig. 13.—Details of ♂ hypopygium of species of *Chironomus*. a, *C.* (*Glyptotendipes*) *mancunianus*, sp. n. b, *C.* (*G.*) *foliicola*, Kieff. c–f, dorsal basal appendage of (respectively) *C.* (*Microtendipes*) *pedellus*, De G., *C.* (*M.*) *diffinis*, sp. n., *C.* (*M.*) *confinis*, sp. n. and *C.* (*M.*) *britteni*, sp. n. d′, anal point of *C. diffinis*, sp. n. f′, anal point of *C. britteni*, sp. n. g, *C.* (*Microtendipes*) *hibernicus*, sp. n., left half from beneath. h, *C.* (*Paratendipes*) *nudisquama*, sp. n., basal appendages from beneath. i, *C.* (*Polypedilum*) *apfelbecki*, Strobl, from above. j, *C.* (*P.*) *prolixitarsis*, Lundst. k, *C.* (*P.*) *acutus*, Kieff. l, *C.* (*P.*) *convictus*, Walk., appendage l. m, *C.* (*P.*) *rydalensis*, sp. n., right half from above. n, *C.* (*Lauterborniella*) *brachylabis*, sp. n. o, *C.* (*L.*) *orophilus*, sp. n.

lum pale; postnotum, sternum and pleurae blackish. Abdomen with segments 1–5 clear pale green, 6–9 darkened, but lighter at sides. Hypopygium almost as in *C. pedellus*, but appendage 1 (fig. 13*d*) with only about 3–4 hairs. Legs lighter than in *C. pedellus*; front femur yellow with the tip rather narrowly black; front tibia with about the basal fourth blackened, tip also black; tips of first two or three segments of front tarsi more or less darkened; no beard; L.R. about 1·2. Wings as in *C. pedellus*. Halteres pale. Wing-length 4 mm. Quy, Cambs. (*F.W.E.*).

C. (M.) britteni, sp. n. ♂. Colouring of head, thorax and abdomen as in *C. diffinis*. Hypopygium with shorter anal point than in the last three (fig. 13*f'*); appendage 1 as seen from above (fig. 13*f*) sharply pointed, with three long hairs on outer margin near middle and one on inner margin near base; in side view the appendage is seen to be bent downwards near tip. Front femur dark at tip only, as in *C. diffinis*; front tibia entirely black; first two segments of front tarsi not darkened apically; no beard; L.R. about 1·2. Wings as in *C. pedellus*, length 4 mm. Melkinthorpe, Westmorland, and Skirwith, Cumberland (*Britten*).

C. (M.) confinis, Mg. (*zonarius*, Walk.; *perreptans*, Walk.; *lentulus*, Walk.; *obvertens*, Walk.; *separatus*, Walk.; *pseudopedellus*, Goet.). Thorax rather heavily pruinose, except on scutal stripes, which are reddish-brown to black and somewhat shining. Abdomen light olive-green; extreme bases of tergites 2–5 with a black transverse line, basal third to half of these segments also somewhat darkened; 6–8 all dark. Hypopygium with short anal point as in *C. britteni*, but appendage 1 (fig. 13*e*) rather differently shaped. Legs almost as in *C. diffinis*, but front tarsus with very slight beard and L.R. only about 1·1. Lewes (*Verrall*); Reading (*Gotch*).

C. (M.) hibernicus, sp. n. ♂. *Head* and mouth-parts black. Antennae with scape shining black, flagellum dark brown, plumes black; A.R. about 1·8. *Thorax* shining black, with faint traces of grey dusting; pleural membrane rather light greenish. Pronotum reduced as usual in this group, but scutum not conspicuously produced forwards. *Abdomen* with segments 1–5 olive-green, remainder dark brownish. Hypopygium mainly dark, but styles pale; ventral appendages *shining black*. Hypopygium (fig. 13*g*) very much as in *C. gibbus*, F., but appendages rather less elongate. Styles slender, with long hairs internally on outer half; anal point long and slender; appendage 1 very small and hidden, with 4–5 short hairs ventrally; 2 very long and slender, pubescent at base beneath, reaching well beyond middle of styles, ending in a small spine and with about five long hairs in addition. *Legs* brownish, tarsi indistinctly lighter (front tarsi missing in type); no special darkening at tips of femora or on front tibiae. Middle tibia with two small spurs; hind tibia with a rather short spur on the smaller comb only, none on the larger comb. Pulvilli over half as long as claws. *Wings* quite unmarked and with a faint milky tinge by reflected light. R_{2+3} very close to but not quite in contact with R_1 at tip; *fCu* well beyond *r-m*. Halteres pale yellow. Wing-length 3·2 mm.

Killarney, S.W. Ireland, 25–27.v.1929, 1 ♂ (*F.W.E.*).

Although I have only one somewhat damaged specimen I describe it because it seems of unusual interest and very distinctive, having the colouring of *C.* (*M.*) *chloris* and the hypopygial structure of the subgenus *Stenochironomus*, with tibial spurs intermediate between the two. The appearance of the specimen suggests that it may be a hybrid between *C. choris* and *C. gibbus*, but we are entirely ignorant at present as to the extent to which hybridisation

may occur in the CHIRONOMIDAE, and one would not expect it between two such dissimilar species.

C. (M.) fuscipennis, Mg. (*pedestris*, Mg.; *pictipes*, Zett.; *patens*, Walk.). Antennae rather light in colour, A.R. hardly over 1. Thorax shining black. Abdominal segments 1–5 yellowish or green, 6–8 black. Hypopygium with styles long, dark; appendage 2 yellowish, with one long apical hair. Legs yellow, except the front femora, which have a broad black band on the outer half, sometimes leaving the tip yellow. Wings with the outer two-thirds somewhat smoky, especially in ♀. R_{2+3} running close to R_1, but separated from it at the tip by fully the width of a vein. Locally common.

This species is intermediate between *Microtendipes* and *Polypedilum*, the hypopygium being quite of the type of the latter subgenus, although in size and colour, as well as the 7-segmented ♀ antennae, it resembles the former.

C. (M.) nitidus, Mg. (? *vagans*, Mg.). ♂. Antennae with the scape black, first few segments of flagellum yellow, remaining segments and plumes dark brown. Palpi blackish. Body entirely shining black. Pronotum as in the subgenus *Endochironomus*, reaching anterior margin of scutum but flattened and divided in middle. Hypopygium practically as in *C. dispar*, but appendage 1 a little more curved than shown in Goetghebuer's figure, its extreme base a little enlarged and hairy. *Legs* entirely yellow. Front tarsi without beard, L.R. 1·05. Tibial combs as in *C. pedellus*. Pulvilli almost as long as claws. *Wings* greyish-hyaline, veins all pale. R_{2+3} separated from R_1 at the tip by a little more than the width of the latter. Base of cubital fork well beyond *r-m*. Halteres pale yellowish. Length of body 5·5 mm.; wing 3·5 mm.

Knebworth, Herts., 13.v.1923, 2 ♂♂ (*F.W.E.*).

This species is intermediate between *Microtendipes* and *Endochironomus*, the tibial spurs being as in the former, the pronotum and hypopygium as in the latter, and the venation intermediate. The specimens answer to my notes on Meigen's type of *C. nitidus*.

Subgenus **Stictochironomus,** Kieff.

Antennae of ♂ with 14 segments (abnormally 13), of ♀ with 6 segments. No frontal tubercles. Pronotum reduced, not visible dorsally. Scutum with a slight hump (almost a tubercle) in the middle, situated at hind end of median stripe. Male hypopygium with longish styles; appendage 2 without distinctly differentiated apical hair. Tibial combs fused, a single spur of moderate length on outer side of hind tibia and posterior side of middle tibia. Femora and tibiae usually ringed. Pulvilli present but rather small. Wings with at least a central black spot. R_{2+3} distinct and ending well beyond tip of R_1; *fCu* just before or below *r-m*.

This is a small and fairly well-defined group of which we have four British species. All are of medium size, the body dull blackish or dark grey, the abdominal tergites with the apical margins conspicuously pale, sometimes almost silvery.

C. (S.) maculipennis, Mg. Femora with a yellowish pre-apical ring; tibiae with three dark and two light rings; extreme tips of femora and bases of tibiae pale; front tarsi of ♂ bearded. Wings with very distinct cloudy spots; one between *M* and Cu_1. Rugby (*Austen*); Minchinhampton, Glos. (*Miss Ricardo*); Thurgarton, Notts. (*Carr*); Edinburgh (*Grimshaw*).

C. (S.) pictulus, Mg. Legs almost as in *C. maculipennis*, but ♂ tarsi without beard, and extreme tips of femora and bases of tibiae dark. Wings with the cloudy markings fainter, none between *M* and Cu_1. Rather common.

C. (S.) histrio, Fab. (? *sticticus*, Fab.). Body blacker than in the last two, and hind margins of abdominal tergites more silvery white. Femora black with a narrow yellow subapical ring; four anterior tibiae whitish with the two ends black; hind tibiae also with a dark ring in middle. Wings whitish with a small black spot over *r-m*. Hawnby, Yorks. (*F.W.E.*).

C. (S.) rosenschöldi, Zett. (*assimilis*, Zett.; ? *oppetitus*, Walk.). Legs dark, without rings. Wings with *r-m* and surrounding veins black, no clouds on membrane. L.R. 1·05–1·2. Leeds (*Hincks*); Killarney and Windermere (*F.W.E.*).

Subgenus **Polypedilum,** Kieff.

(*Pentapelma*, Kieff., 1921, Ann. Soc. Sci. Brux. 41, p. 98.)

Antennae of ♂ 14-segmented, of ♀ 6-segmented. No frontal tubercles. Pronotum much reduced, usually overhung by the scutum and not visible from above. Scutum without a distinct hump in middle. Male styles usually rather long and slender; appendage 2 with several curved hairs and usually one long apical hair. Front tibia (? always) with a very short spur. Hind tibia with inner comb large and simple, outer small, with a longish spur; middle tibia with long spur on posterior comb. No distinct rings on tibiae. Wings with or without dark clouds. R_{2+3} rather faint and ending not far beyond tip of R_1; R_{4+5} ending above tip of M as usual; *fCu* slightly or considerably beyond *r-m*.

According to Kieffer the principal character of the subgenus is the presence of four slender pulvilli instead of the usual two broad ones, but in all the species I have examined the pulvilli have the normal form. This is the case even with the genotype, *C. nubeculosus*, Mg. (= *emarginatum*, Kieff., according to Goetghebuer), and with *C. convictus*, Walk. (? = *blandus*, v.d.W.), which is figured by Goetghebuer as having four narrow pulvilli; I have carefully examined stained specimens mounted under a high power and examined under all aspects, without being able to detect split pulvilli, and am not convinced that such structures exist in nature.

We have about twelve species in Britain, some of which have rather well-marked varieties, all being fairly easy to distinguish. Some of the smaller plain-winged species rather closely resemble those of the subgenus *Lauterborniella*, but have the squama very distinctly fringed, and costa ending above instead of before the level of the tip of *M*. *C. pedestris*, Mg., has been referred to this subgenus by Kieffer and Goetghebuer, but it seems to me better placed in *Microtendipes*.

1. Body mainly or all black . . . . . 2.
   Abdomen light green or yellowish . . . . . 12.
2. Wings with spots or clouds . . . . . 3.
   Wings unmarked, at most some veins seamed with grey . . . . . 8.
3. Halteres yellow . . . . . 4.
   Halteres with dark knob . . . . . 7.
4. Wings with distinct spots . . . . . 5.
   Wings with faint clouds only, two in cell R_5 . . . . . *leucopus*, Mg.
5. Wings with numerous spots, two large ones in cell R_5 . . *apfelbecki*, Strobl.
   Wings with only three distinct spots, one in cell R_5 . . . . . 6.
6. Spot in cell R_5 at or close to base of cell . . . . . *scalaenus*, Schr.
   Spot in cell R_5 well removed from base of cell var. (?) *quadriguttatus*, Kieff.
7. Several wing-spots; outer one in cell R_5 long and narrow . . . *laetus*, Mg.
   Two rather faint clouds in cell R_5; other markings indistinct . *nubeculosus*, Mg.
8. Halteres yellow . . . . . 9.
   Halteres with blackish knob . . . . . 10.

9. Antennal plume yellowish; ♂ ninth tergite not trilobed . . . *albicornis*, Mg.
   Antennal plume darkened; ♂ ninth tergite trilobed . . *prolixitarsis*, Lundst.
10. Anal area of ♂ wing rather obtuse; wing-length 2–2·5 mm.; ninth tergite trilobed . . . . . *flavonervosus*, Staeg.
    Anal area of ♂ wing better developed; wing-length 3–4 mm.; ninth tergite not trilobed . . . . . 11.
11. A.R. 1·2–1·5; wings greyish . . . . . *arundineti*, Goet.
    A.R. 2–2·5; wings clearer . . . . . *nubeculosus*, Mg., var.
12. Thorax (♂) or at least postnotum (♀) blackish . . . . . *acutus*, Kieff.
    Thorax yellow (♂♀) . . . . . 13.
13. Legs shorter, L.R. about 1·5–1·7 . . . . . *convictus*, Walk.
    Legs longer, L.R. only 1·3 . . . . . *rydalensis*, sp. n.

C. (P.) apfelbecki, Strobl. Head blackish; antennae pale, especially in ♀. A.R. about 0·8. Thorax dark brown, rather heavily pruinose, especially between scutal stripes, which are rather lighter in ♂. Abdomen blackish, hypopygium of ♂ and cerci of ♀ yellowish; ♂ styles long and slender, ninth tergite without lateral teeth; appendage 1 broad and pubescent, 2 with the two outermost hairs long but incurved (fig. 13*i*). Legs with femora mainly dark brown, tips black; before the tip on each femur is a distinct yellow ring, narrower than the black tip. Tibiae brownish, tips black. Tarsi uniformly light brownish. L.R. about 1·85, second tarsal segment fully as long as tibia. Wings (Plate XIX, fig. 13) slightly milky by reflected light, with a conspicuous pattern of dark grey markings as shown in figure. Squamal fringe short but well developed. Halteres whitish. Wing-length 2 mm. Barton Hills, Beds., 8–9.vii.1928, 1 ♂ 1 ♀ (*F.W.E.*); also 1 ♀ in Mr. Collin's collection without exact data, but received from C. W. Dale and therefore probably from Dorset.

In many respects this resembles *C. quadrimaculatus*, Mg., as described by Goetghebuer, but the wing-markings are more extensive. Our specimens differ from Strobl's description in having no dark area at the base of the tibiae.

C. (P.) scalaenus, Schr. Blackish; halteres and legs pale in both sexes; knees and tips of tibiae only very narrowly dark. Wings with three dark spots, the one in cell R_5 placed at or close to the base of this cell; no trace of darkening in cell M beyond the dark spots. Ninth tergite of ♂ trilobed, lateral lobes short. Thames Valley near London; often taken in British Museum (Natural History).

Var.? *quadriguttatus*, Kieff. Much like the type, but hind femora more or less darkened on basal two-thirds, especially in ♀, tip also rather broadly blackish; wing-markings stronger, spot in cell R_5 about its own length distant from base of cell; a small dark spot in cell M just distal to the spot in cell R_5 (distinct in ♀, faintly indicated in ♂); margin of wing at tip also slightly darkened. Cardington, Beds.; Letchworth, Herts.; Temple Sowerby, Westmorland (*F.W.E.*); Salisbury (*Miss Ricardo*).

C. (P.) laetus, Mg. (*nubilipennis*, Mg.; *falciger*, Kieff.). Blackish, with black halteres. A large dark spot in base of cell R_5, and a dark streak towards the end of this cell close to vein M, the latter mark rather variable, sometimes practically absent; a dark cloud across base of Cu_2, another at its tip, and another large one in anal cell. Common in hilly districts.

This was determined by Verrall as *C. nubilus*, Mg., but Meigen's type belongs to quite a different species.

C. (P.) nubeculosus, Mg. (*enotatus*, Walk.; *emarginatum*, Kieff.). Blackish, with black halteres. Two rather faint clouds in cell R_5, one at base and one beyond middle, these markings sometimes almost or quite indistinguishable;

ground-colour of wing whitish. A.R. 2–2·5. Front tarsi of ♂ with short beard. Common.

This is the largest species of the subgenus (wing-length 3·5–4 mm.). The pronotum is better developed than in the other species, and has almost the same form as in the subgenus *Endochironomus*.

C. (P.) leucopus, Mg. (*nec* Goet.). Blackish; halteres and legs entirely pale yellow. Wings with very faint clouds, arranged as in *C. nubeculosus* and visible only by reflected light when the wing is held obliquely. Hypopygium practically as in *C. nubeculosus*. A.R. nearly 2. Burley-in-Wharfedale, 1 ♂ (*Grimshaw*).

This may be only a pale form of *C. nubeculosus*. It agrees with Meigen's type of *C. leucopus* in Paris, which according to my notes has faint clouds on the wing and pale halteres. The specimen from Meigen's collection noted by Goetghebuer as having dark halteres could not have been the type.

C. (P.) albicornis, Mg. (*pullus*, Goet., ? Zett.). Body black, halteres and legs pale yellow, also all the wing-veins; antennal plume of ♂ yellowish. L.R. about 1·4; no tarsal beard. Ninth tergite of hypopygium with long slender point, not trilobed; appendage 1 slender and bare. Locally common.

The remnants of Meigen's type, as well as his description, correspond with our species. On the other hand, Zetterstedt's type has a yellow instead of a black hypopygium, and according to his description the antennal plume is brown, with the tip paler; it would seem therefore that he may have described another species.

C. (P.) prolixitarsis, Lundst., 1916. Body all black, scutellum and shoulders more or less pale, at least in ♀; scutum with the usual grey reflections between the stripes. Antennal plume dark, A.R. about 1·7. Hypopygium (fig. 13*j*) dark; styles very slender and pointed, with the usual long hairs on the inner side; ninth tergite trilobed; appendage 1 broad, flat, pubescent, with several longer hairs; 2 with terminal hair only moderately long. Legs yellowish; no tarsal beard; L.R. about 1·6. Wings clear, but with grey seams over part of M, whole of Cu_2 and part of anal fold, more distinct in life, but readily seen in the pinned specimen if the wing is held very obliquely. Costa and radial branches slightly darkened. Halteres entirely whitish-yellow. Anal lobe almost right-angled. Wing-length about 2·5–3 mm. Sandy and Biggleswade, Beds. (*F.W.E.*); Netley, Hants. (*Miss Ricardo*). Lundström describes the veins as "pale and transparent," but his description and figure otherwise correspond with our material.

A variety (?) differs in having the legs much darker, femora almost black, and the grey seams on the veins less distinct. The hypopygium does not differ. Keighley, Yorks. (*Butterfield*); Windermere (*F.W.E.*); Rostherne, Cheshire (*Britten*).

C. (P.) flavonervosus, Staeg. ? (? *bicrenatum*, Kieff., 1921*d*). Similar to the last (hypopygium practically identical in structure), but rather smaller; less obvious grey seams on the veins; wing rather narrower, anal area somewhat more rounded; and halteres with blackish knobs. Salisbury (*Miss Ricardo*); Cardington, Beds. (*F.W.E.*); Manchester (*Britten*). Staeger's type (a female) differs from our males in having the anterior wing-veins yellow instead of light brownish.

The North American *C. halteralis*, Coq., is very similar, but according to Malloch's figure is distinguishable by having the male styles constricted in the middle.

C. (P.) arundineti, Goet. Body all blackish. Antennal plume dark,

A.R. under 1·5. Legs light to dark brownish, usually lighter in ♀; wings greyish, but without definite clouds, veins more or less darkened. Hypopygium with simple anal point; styles stout; appendage 1 with one long hair arising from near base. No tarsal beard. Halteres with blackish knob. Common.

The variety of *C. nubeculosus* which lacks the clouds on the wing may be distinguished by its larger size, A.R. 2 or more, small differences in the hypopygium, and presence of short tarsal beard.

C. (P.) acutus, Kieff. (1915*d*) var. ♂. *Head* with palpi and flagellum of antennae entirely pale yellowish, including the plumes. A.R. about 1·5. *Thorax* brownish, somewhat pruinose; scutal stripes, postnotum and sternum blackish brown, somewhat shining. *Abdomen* pale green, with pale hair. Styles long, moderately slender and somewhat pointed, with a few long hairs on inner side; ninth tergite with simple point; appendage 1 linear, bare, slightly hooked at tip; 2 with usual long terminal hair (fig. 13*k*). *Legs* whitish, except for the black tibial combs. No tarsal beard; L.R. about 1·4. *Wings* whitish-hyaline, veins all pale. Lobe right-angled. Halteres whitish. Wing-length 3·3 mm. ♀. Thorax light brownish; scutal stripes and sternum slightly darker, scutellum lighter; postnotum with the posterior half to two-thirds black. Abdomen with the first few segments green, rest darkened. Gormire, Yorks.; Witherslack, Westmorland; Epping Forest (*F.W.E.*).

This is regarded as a variety of Kieffer's *Polypedilum acutum*; according to the description that species has the A.R. 1·0, but the colour of body and structure of hypopygium are as in our specimens.

C. (P.) convictus, Walk. (*blandus*, v.d.W.; *nympha*, Kieff.). Light yellowish-green; scape, scutal stripes and postnotum yellow; legs yellow; antennal plume darkened. A.R. about 1·5–1·8. No tarsal beard; L.R. 1·5–1·7; pulvilli rather large, but empodium longer still. Hypopygium with appendage 1 (fig. 13*l*) much swollen at base, narrowed on the apical half, which faces inwards; 2 with the usual long apical hair. Wing-length about 2·8 mm. Rather common.

C. (P.) rydalensis, sp. n. ♂. Coloration as in *C. convictus*, but size rather larger (wing-length about 3·3 mm.). Legs more slender, especially front pair, but L.R. only 1·3, the increase in length being chiefly in the tibia; pulvilli smaller, empodium not longer than pulvilli. Appendage 1 broader apically than at base, 2 *without* the long apical hair; at base of appendage 2 beneath is a small tubercle bearing a number of setae, evidently representing a rudimentary appendage 2*a* (fig. 13*m*). Rydal, Westmorland (*F.W.E.*).

Subgenus **Lauterborniella,** Bause.

Antennae of ♂ 13–14-segmented (last one or two joints often very indistinct), of ♀ 6-segmented. Pronotum reduced, not visible from above. Hypopygium with ninth tergite normal, appendage 1 not pubescent, with one or two long hairs only, 2 normal, 2*a* absent. Front tibia with shortish, slender spur; combs of posterior tibiae very unequal, larger unarmed, smaller with long spur. Pulvilli well developed. Squama without fringe (or at most with 1–3 short hairs). Costa often somewhat retracted; *fCu* well beyond *r-m*.

This subgenus was proposed by Bause for two species (*marmoratus* and *agrayloides*) on account of the case-forming habits of the larvae. The first species was removed by Kieffer to a new genus *Zavreliella*, but I find that the two agree in having a bare squama and in most other respects, and therefore include them both under *Lauterborniella*; they represent two rather distinct

groups, but both seem to be derived from the subgenus *Polypedilum*, from which they differ chiefly in the bare squama. The adult morphology confirms the conclusion recently expressed by Zavrel that they are related to *Chironomus* and not to the subgenus *Zavrelia* of *Tanytarsus*, as formerly suggested by Bause.

Group A.

(*Zavreliella*, Kieff.)

Front femora somewhat clubbed on apical half. Wings spotted; R_{4+5} ending level with tip of *M*.

C. (L.) marmoratus, v.d.W. (*flexilis*, Bause, ? Linn.; * *clavaticrus*, Kieff.). Blackish; wings with numerous dark grey spots; femora and tibiae ringed; tarsi white, with dark rings at tips of segments; L.R. 2. Letchworth, Herts. (*F.W.E.*).

The male is unknown, the species sometimes and perhaps always reproducing by parthenogenesis. In the allied American *C. perpulcher*, Mitchell, both sexes are about equally numerous; the male hypopygium is similar in type to that of *C. agrayloides*.

Group B.

(*Lauterborniella*, s. str.)

Front femora slender; wings unmarked; R_{4+5} ending slightly but distinctly before tip of *M*.

C. (L.) agrayloides (Kieff.), 1911*a*. A very small black species; wings hyaline, halteres, legs, antennae, and ♂ styles whitish. Anal area of wing very much reduced, lobe scarcely indicated. A.R. about 1. L.R. about 1·25. Styles slender, twice as long as coxites. Wing-length 1·5 mm. Epping (*F.W.E.*).

Kieffer gives 13 as the number of antennal segments; our specimens have 14, but the last two joints are very indistinct.

C. (L.) orophilus, sp. n. Very similar to *C. agrayloides*, but rather larger (wing-length 2 mm.); legs and antennae darker; A.R. 1·5; L.R. about 1·1; anal area of wing much less reduced; squama in some specimens with 1–3 small hairs (in others quite bare). Hypopygium (fig. 13*o*) much as in *C. agrayloides*: styles about twice as long as coxites, slender, but not narrowed at tip; appendage 2 hardly longer than 1, reaching only a little beyond end of coxite; 1 narrowed and slightly hooked at tip, with a single short hair on outer side beyond middle. Anal point long and rather broad. Wings (Plate XIX, fig. 14) with a more pronounced milky tinge than in *C. agrayloides*; cubital fork not quite so short; *r-m* less oblique. Llyn Gwynant, Carnarvonshire; Windermere; Killarney (*F.W.E.*); Brathay Valley, Westmorland (*Britten*).

* It is probable that Bause is correct in regarding this as the true *C. flexilis*, L.; certainly the words "*corpus minimum, nigricans*" in the original diagnosis would apply to this species better than to *C. gibbus*, F., and though Linnaeus gives no references, it seems likely from its position between *Tipula motitatrix* and *T. monilis* (Geoffroy's Nos. 18 and 20) that the name *flexilis* was introduced to designate Geoffroy's No. 19*b*. Geoffroy's adult No. 19*b* was evidently not our species, but his notes on the larvae (quoted from Réaumur) do seem to apply to *C. marmoratus*. Linnaeus may have looked up Réaumur's work from Geoffroy's reference and added the character of the banded wings from Réaumur's figure. All this, however, is conjecture, and I prefer to use the name *marmoratus* for the species, especially in view of the past misuse of *flexilis* for *C. gibbus*, Fab.

C. (L.) brachylabis, sp. n. Very similar to the last two, but halteres black like the whole body; legs and antennae dark. A.R. 1·2; L.R. 1·15. Wings with a slight milky tinge, 1·7 mm. in length, anal area small, lobe obtusely rounded. Hypopygium (fig. 13*n*) black; styles very short, half as long as coxites (possibly an individual abnormality); anal point short, slender, pointed; appendage 1 with two hairs on inner side towards base, curved, with rounded tip; 2 much longer and clubbed. Cubital fork longer than in the last two, distant from *r-m* only by about twice the length of the cross-vein. Squama quite bare. Cambridge, 28.vii.1915, 1 ♂ (*Jenkinson*).

TANYTARSUS, v.d. Wulp.

Wings with hairs on the membrane, at least at extreme tip in cell R_5, also on most of the veins. Squama quite bare. Cross-vein *r-m* more or less horizontal (*i.e.* continuing the direction of *M*) and usually very short, never distinct and oblique as in *Chironomus*. R_{4+5} usually straight and running rather close to R_1. *An* almost or quite straight (not distinctly curved down at tip as in *Chironomus*), more divergent from *Cu* than in *Chironomus*, and reaching scarcely if at all beyond base of fork. Anal area of wing small, lobe obtusely rounded or absent. Antennae of ♂ 11–14 segmented, of ♀ 5–7 segmented. Pronotum reduced, never distinctly visible from above. Hypopygium of ♂ with appendage 1 short and broad; 1*a* nearly always present, usually finger-like; 2 reaching a little beyond end of coxite and with long curved hairs; 2*a* nearly always present but variable in development, often with peculiarly modified hairs.

As originally defined, *Tanytarsus* included all CHIRONOMINAE with hairy wings and L.R. more than 1. A large number of divisions of the old genus have been proposed by Kieffer, mostly on very slight characters which should not in my opinion be regarded as even of subgeneric value. I would, however, exclude from *Tanytarsus* all species possessing hairs on the squama; these are obviously more nearly related to *Chironomus* and have been dealt with under the genus *Pentapedilum*.

As elsewhere explained (p. 375), Coquillett's designation of *punctipes*, Wied., as the genotype of *Tanytarsus* is invalid; it should be replaced by *signatus*, v.d.W.

I am already acquainted with nearly 50 species of *Tanytarsus* in Britain; if, as I believe, the characters used for their definition are reliable, we probably possess double this number. I agree with Goetghebuer in regarding the characters of the tibial spurs and combs as of the first importance in the division of the genus, but prefer to treat even the divisions so made as subgenera, and regard the size of the combs and their separation or fusion as more important than the presence or absence of spurs. The subgenera occurring in Britain may be distinguished by the following key.

1. Tibial combs quite confluent ventrally, occupying more than half circumference of tibia; eyes bare; wings not very narrow . . . . . 2.
   Tibial combs at least narrowly separated ventrally, occupying at most half circumference of tibia . . . . . 3.
2. Fused combs without spurs (fig. 10*i*) . . . . . *Micropsectra.*
   Fused combs with one or two short spurs (fig. 10*j*, *k*) . . . . *Lundströmia.*
3. At least one comb spurred (fig. 10*l*, *m*) . . . . . 4.
   Neither comb spurred . . . . . *Phaenopelma.*
4. Eyes pubescent; wings cuneiform . . . . . *Zavrelia.*
   Eyes bare as usual . . . . . 5.

5. Scutellum with several long marginal hairs; both combs usually spurred; wings not cuneiform; R_{4+5} usually ending just beyond tip of Cu_1 *Tanytarsus*.
Scutellum with only two long marginal hairs; one comb without spur; wings often cuneiform; R_{4+5} ending above or before tip of Cu_1 *Stempellina*.

Subgenus **Micropsectra,** Kieff.

(*Eutanytarsus*, Bause; *Syntanytarsus*, Bause.)

Combs of the four posterior tibiae entirely confluent ventrally and devoid of spurs. L.R. about 1·5–1·7. Antennae of ♂ 14-segmented, A.R. usually 1·2–1·7. Antennae of ♀ 6-segmented, 2 strongly constricted and perhaps sometimes divided in middle, 6 and 7 separate. Wings (in all British species) hairy on the greater part of their surface; *r-m* two or three times as long as the short basal section of *Rs*; *fCu* below or even a little before base of *Rs*; Cu_1 very gently curved, not bent down near tip. No frontal tubercles.

The genotype (*inermipes*, Kieff.) has not been properly described, but from the brief diagnosis given it would seem to resemble *T. brunnipes*; that species is therefore taken as typifying the subgenus. Kieffer included only species with very small pulvilli, but the first and last of those mentioned below have the pulvilli well developed.

We have about seven British species, some of which are among the largest of the genus. Goetghebuer (*Faune de France*) refers to this subgenus *T. tenellulus*, *T. laetipes* and *T. nigrofasciatus*, but these all have separated and spurred tibial combs.

T. (M.) fuscus (Mg.) (*tonnoiri*, Goet.). Thorax entirely black in both sexes and moderately shining; abdomen and legs dark; halteres dark, especially in ♂. Pulvilli quite half as long as claws. A.R. nearly 2. Abundant on moors in most parts of the country.

T. (M.) brunnipes (Zett.) (*appositus*, Walk.; *intrudens*, Walk.; *nactus*, Walk.; *notescens*, Walk.; *occipiens*, Walk.; *offectus*, Walk.; *gmundensis*, Egg.; ? *inermipes*, Kieff., etc.*). A dark species something like *T. fuscus*, but thorax scarcely shining; shoulders pale in ♂; scutal stripes usually fused in ♂, separate in ♀; halteres whitish; pulvilli absent. Abdomen in ♂ all dark. A.R. about 1·3–1·5. Appendage 2*a* rather short, not reaching end of 1, hairs of brush with enlarged tips; 1*a* hidden under 1. Abundant everywhere.

I have adopted Zetterstedt's name for this species rather than one of Walker's (all of which antedate *gmundensis*), because the type of *brunnipes* appears to belong here, but its hypopygium has not been examined. Zetterstedt included specimens of an *Orthocladius* in his series of *brunnipes*, which may perhaps account for his statement that the wings are bare.

T. (M.) subviridis, Goet. Similar to *T. brunnipes*, but paler; scutal stripes well separated (♂♀); legs pale brownish; abdomen in ♂ olive-green (lighter or darker) with the last few segments blackish; appendage 2*a* rather longer. Rather common and widely distributed.

Described as a variety of *T. gmundensis*, but is probably a distinct species. The hypopygium is very similar to that of *T. globulifer*, Goet., which is said to have dark bands on the abdominal tergites.

T. (M.) sp. Resembles *T. brunnipes*, differing somewhat in the hypopygium, the hairs of the brush being more blade-like. Slapton, S. Devon (*Verrall*).

* Specimens received from Thienemann as *T.* (*Micropsectra*) *exsectus*, *hemipsilus*, *insularis*, *lanceolatus*, *longimanus*, *terminalis* and *tetratomus*, Kieff., are referable to this species.

T. (M.) recurvatus, Goet. Resembles *T. brunnipes*, but small pulvilli present, and hypopygium differs: appendage 1*a* free, not covered by 1; 2 more slender and curved inwards; 2*a* almost as long as 2, slender, with fewer globuliferous hairs at its tip. Broadheath, Cheshire, 16.iv.1921, 2 ♂♂ (*Britten*).

T. (M.) atrofasciatus, Kieff. (*sexannulatus*, Goet.). Abdominal tergites 2–7 of ♂ each with the posterior margin narrowly but distinctly dark; ground-colour of thorax and abdomen variable, light to dark green; scutal stripes light yellowish to black, in the darkest specimens (? var. *subnitens*, Goet.) sometimes fused. Appendage 1 almost circular, 1*a* absent, 2*a* as in *T. subviridis*. Abundant.

T. (M.) retusus, Goet. Pale green; scape, scutal stripes, postnotum and sternum brownish to black. A.R. about 1. Hypopygium with appendage 1*a* prominent; 2*a* as in the last three. Ilkley (*Grace*); Snailbeach and Church Stretton, Salop; Sanox, Arran (*F.W.E.*); Colne, Lancs. (*Britten*).

T. (M.) monticola, sp. n. ♂. Differs from all the other species in having A.R. only about 0·6, segments 10–13 of antenna fully twice as long as broad and only indistinctly separated. Rather light olive-green; scape, scutal stripes, postnotum and sternum dark brown; legs pale. L.R. about 1·5; pulvilli present, over half as long as claws. Hypopygium (fig. 14*a*) much as in *T. brunnipes*, but styles longer and more slender; appendage 1*a* shorter, almost triangular; 2*a* with hairs of brush more uniformly thickened throughout, not specially enlarged at their tips. Wings as in *T. brunnipes*.

♀. Scutal stripes and sternum scarcely darker than ground-colour, postnotum dark brown. Abdomen pale. Antennae with scape pale; segment 2 constricted in middle as usual, 6 not much longer than 5, the long terminal hair missing (possibly broken off). Wing-length about 2·2 mm.

Corriegills, Arran, type ♂ and ♀; Brothers' Water, Westmorland, 1 ♂ (*F.W.E.*). This is the smallest species of the subgenus in Britain. It may perhaps be Kieffer's *T. praticola*, the hypopygium agreeing with a damaged specimen received from Thienemann, but Kieffer's species is said to have the A.R. 1·0.

Subgenus **Lundströmia,** Kieff.

(Including *Ditanytarsus*, Kieff., Goet.; ? *Paratanytarsus*, Bause; *Stylotanytarsus*, Kieff.)

Combs of four posterior tibiae entirely confluent ventrally, with one or two short spurs. L.R. 1·5 or less. Antennae of ♂ 14-segmented, A.R. 1–1·5. Antennae of ♀ 6-segmented, 2 strongly constricted in middle, 6 and 7 separate. Wings hairy on at least the apical half; *r-m* variable; *fCu* below or scarcely before base of *Rs*; Cu_1 rather more sinuous apically than in subgenus *Micropsectra*.

I am acquainted with five British species of this subgenus; none of them are identical with any of the five referred here by Goetghebuer, some of which may also occur with us.

T. (L.) praecox (Mg.) Goet. A rather large dark species which might be confused with *T. brunnipes*, but wings much less hairy; anal cell in ♂ almost or quite bare; front tarsi of ♂ with slight beard, and L.R. only 1·2 or slightly less. No frontal tubercles, and no pulvilli. Appendage 2*a* almost as long as 2, stout and densely covered with simple hairs. Tibial combs with one short spur. Cross-vein *r-m* almost as long as in *T. brunnipes* and related species. Common.

T. (L.) bituberculatus, sp. n. ♂. Head and thorax black, somewhat shining, shoulders indistinctly greenish, prescutellar area indistinctly lighter and

somewhat dusted with grey. Abdomen olive-green. Legs dark. No frontal tubercles or pulvilli. A.R. about 1·4; L.R. about 1·4; no definite tarsal beard. Tibial combs with one short spur. Ninth tergite (fig. 14*b*) with a pair of small tubercles, each bearing a hair, some distance behind anal point; also with a small fleshy tooth (not always obvious) towards each side on posterior margin. Anal point rather short, rounded, with peculiar sculpturing. Appendages 1, 1*a* and 2 much as in *T. praecox*, but 2*a* very short, less than half as long as 2 and ending in a tuft of lamellae. Wings more uniformly hairy than in *T. praecox*; *r-m* short, scarcely longer than basal section of *Rs*.

♀. Entirely yellow (probably green in life), not even the postnotum darkened. Last (6th) antennal segment 1·3 times as long as penultimate. Venation as in ♂, but wings more hairy. Wing-length 3 mm.

Minchinhampton, Glos., iv.–v.1896, 8 ♂♂ 1 ♀ (*Miss Ricardo*); Oxford (*Hamm*); Audley End, Essex (*F.W.E.*).

This is very similar to *T. pseudotenellulus*, Goet. (which is also a *Lundströmia*), differing in the much shorter appendage 2*a*.

T. (L.) laccophilus, sp. n. ♂. Resembles the last, but rather smaller (wing-length about 2·3 mm.); head largely pale; small frontal tubercles present; A.R. about 1·2; scutal stripes just separate; abdomen clearer green; legs paler; L.R. about 1·2; small but distinct pulvilli present; hypopygium (fig. 14*c*) with styles shorter; ninth tergite without paired dorsal tubercles; appendage 1 broader. Windermere, 1 ♂ (*F.W.E.*).

T. (L.) penicillatus, Goet. ♂. Thorax rather strongly pruinose, scutal stripes fused, black; postnotum and sternum black; shoulders and pleural patch yellowish, scutellum brown. Abdomen dark olive-green. Legs almost black. Halteres whitish. Apparently no frontal tubercles. A.R. about 1·7. L.R. about 1·4. Tibial combs with two short spurs (apparently only one in some specimens). No pulvilli. Appendage 2*a* long, with large brush of slightly flattened hairs. Wings hairy on apical half only, few or no hairs in anal cell and not very many in cell Cu_1; *r-m* variable in length, but usually about twice as long as basal section of *Rs*.

♀. Resembles ♂, but scutal stripes separate (though blackish in colour) and wings hairy over almost the entire surface. Wing-length about 2·8 mm.

Wicken, Cambs., and Bramhope, Yorks. (*F.W.E.*).

T. (L.) sp. inc. ♀. Resembles the last, but smaller (wing-length about 2·3 mm.) and L.R. only about 1·2. Corriegills, Arran (*F.W.E.*).

Subgenus **Tanytarsus,** s. str.

(Including *Calopsectra*, Kieff., etc. ? *Clinotanytarsus*, Kieff.)

Combs of posterior tibiae at least narrowly separated ventrally, occupying at most half circumference of tibia; usually both combs carry a spur, outer always distinct and fairly long, inner often shorter, more slender and difficult to detect, perhaps sometimes absent. Antennae of ♂ 14- (rarely 13-) segmented, of ♀ 5–7-segmented. Wings with a variable amount of hair; *r-m* (except in *T. tenuis* and one or two other species) very short, scarcely if any longer than basal section of *Rs*; R_{4+5} ending above or beyond level of tip of Cu_1; *f*Cu usually distinctly beyond base of *Rs*; tip of Cu_1 often slightly sinuous; anal area of wing always more or less developed. Scutellum with several long marginal hairs.

This subgenus includes the majority of the British species; about 30 are already known, and doubtless many others occur. Their classification is difficult, for while some species, obviously distinct structurally, are almost identical

in colouring, others, very different in colouring are almost identical in structure of hypopygium and other details. Many species seem to be extremely variable in colour, but in some cases at least the different colour forms are also distinguished by the leg ratio or by the amount of hair on the wing; in these cases therefore it would seem probable that we are dealing with distinct species.

The British species may be arranged in six groups, as follows:—

1. Tibial combs almost confluent, with short spurs (fig. 10*l*) . . . . *Group A.*
   Tibial combs smaller and well separated, one or both spurs usually rather long (fig. 10*m*) . . . . . 2.
2. Pulvilli present, fully half as long as claws . . . . . *Group B.*
   Pulvilli absent or very small . . . . . 3.
3. Wings more hairy; hairs numerous in cell Cu_1 in ♂ . . . . . 4.
   Wings bare except at tip; no hairs (or at most about 6) in cell Cu_1 in ♂ . 5.
4. Male styles with tip very narrow and pointed (fig. 14*l*) . . . . *Group C.*
   Male styles not conspicuously narrowed at tip . . . . . *Group D.*
5. Large black species, ♂ L.R. only 1·2 . . . . . *Group E.*
   Small species, ♂ L.R. at least 1·7 . . . . . *Group F.*

Group A.

Combs of posterior tibiae only very narrowly separated, distance between them very little wider than one of the tibial hairs; combs together occupying about half diameter of tibia, each with a short spur. No distinct pulvilli. Wings hairy on apical half or more. Hypopygium with anal point short; appendage 1*a* present, 2*a* rather long. Antennae of ♀ 6-segmented (2 and 3 fused, but 6 and 7 separate).

This group includes four or five species which in one way or another show an approach to the subgenera *Micropsectra* and *Lundströmia*; they might perhaps be included in the latter.

T. tenuis (Mg.) Goet. (*affinis*, Walk.; *perlevis*, Walk.). Light green; scutum of ♂ usually with separate black stripes, but these sometimes reddish, usually absent in ♀, and sometimes also in ♂. L.R. about 1·5. Cross-vein *r-m* over twice as long as basal section of *Rs*; *fCu* scarcely beyond *r-m*. Appendage 2*a* with a mass of broad flattened bristles (not well shown in Goetghebuer's figure). Anal point shaped as in *T. penicillatus* and *T. bituberculatus*. Common.

T. inopertus, Walk. ♂. Olive-green; scutal stripes black and almost fused; first few abdominal segments with darker apical bands. Legs dark. L.R. about 1·4–1·5. Wings similar to *T. tenuis*, but *r-m* in most specimens not quite so long. Hypopygium (fig. 14*d*) similar to that of *T. tenuis*, but appendage 2*a* shorter, with simple hairs only; differs from *T. junci* in having appendage 1*a* more pointed apically and in other details. Salisbury and New Forest (*Miss Ricardo*); Mildenhall, Suffolk (*F.W.E.*).

A variety (?) differs in being light green, with scutal stripes light reddish, legs pale, and L.R. 1·7. Burnham Beeches; Cardington, Beds.; Beesands, S. Devon (*F.W.E.*).

T. laetipes, Zett. (*punctipes*, Goet. *nec* Wied.). ♂. Thorax shining black, including scutellum; abdomen light green; legs whitish; antennal plumes dark. L.R. 1·6–1·7. Wings whitish; *r-m* short. Hypopygium with anal point as in the last two; appendage 2*a* with a clump of lamellae at tip. ♀. All green, scutal stripes scarcely indicated. Beesands, S. Devon; Epping; Staveley and Witherslack, Westmorland (*F.W.E.*).

This can hardly be Wiedemann's *punctipes*, because of the dark antennal plumes, and because the posterior tibial combs are small and not obvious under a lens. Wiedemann's description of white antennal plumes and a minute black spot (probably the combs) at the tip of the hind tibiae seems to indicate that his species was the *Pentapedilum punctipes* of this paper (Goetghebuer's *Calopsectra semiviridis*).

I have not seen *T. nigrofasciatus*, Goet., which from the description seems to be a variety of *T. laetipes* with separate scutal stripes. Goetghebuer's mention of its occurrence in England was based on specimens of *T. intricatus* misidentified by me.

T. tenellulus, Goet. Yellowish-green, without definite markings. L.R. 2·2. Cross-vein *r-m* short. Hypopygium with short, simple anal point, appendage 2*a* long, with long hairs swollen at their tips as in *T. brunnipes*. Letchworth, Herts. and Arlesey, Beds. (*F.W.E.*).

Group B.

(*Calopsectra*, Kieff.)

Combs well separated, each with a distinct spur, and each occupying less than a quarter of tibial circumference. Pulvilli present, half as long as claws or more. Frontal tubercles present. Wings rather densely hairy; *r-m* very short, *fCu* well beyond *r-m*.

Three or four British species, the first two and the last two being closely allied and perhaps not truly distinct. *T. gregarius* is the type of *Calopsectra*.

T. gregarius, Kieff. (*lobatifrons*, Kieff., Goet.; ? *bathophilus*, Kieff.). ♂ typically pale green, scutal stripes light to dark brownish, posterior ends of lateral pair often darkened, postnotum and sternum blackish, legs pale. Frontal lobes rather large. Palpi long, second segment nearly twice as long as third. Front tarsus with slight beard, L.R. 2·0. Hypopygium (fig. 14*e*) with a median row of dots on anal point; appendage 1 narrowed at tip, with long hairs on inner margin, 1*a* absent, 2*a* short, with some simple hairs and a variable number of flattened blades, these arranged in a fan-like manner as seen in side view, and in some positions and specimens appearing broader, with acuminate tips. R_{4+5} reaching beyond tip of Cu_1. ♀. All green; frontal tubercles small. Antennae 6-segmented (2 and 3 separate, but 6 and 7 fused). Beesands, S. Devon; Quy, Cambs.; Crag Lough, Northumberland (*F.W.E.*); Lough Mask, Galway (*Alcock*).

A variety (?) has the abdomen darker (but light green at incisures), scutal stripes black; palpi shorter. Bonawe, Argyll (*Waterston*); Kincraig, Inverness (*Grimshaw*).

T. lugens, Kieff. (?). Differs from the last in having scutal stripes of ♂ quite black and more or less completely fused, scutellum black; scutal stripes of ♀ dark brown to blackish; abdomen of ♂ very dark olive-green; segments 2–4 of palpi subequal in length; L.R. 1·7–1·85; appendage 1 not narrowed at tip, with shorter hairs. Lea Valley, N. London (*R. Nichols*); Levenshulme, Manchester (*Britten*).

T. reflexens, sp. n. ♂. Thorax with light brownish ground-colour; scutal stripes, postnotum and sternum blackish, scutellum dark brown; prescutellar area and spaces between scutal stripes conspicuously dusted with grey. Abdomen dark olive-green, with narrow light green bands at incisures, conspicuous under a lens. Legs light brownish, tip of front femur and most of front tibia and tarsus dark brown. Halteres pale. Frontal tubercles small. Palpi not

Fig. 14.—♂. Hypopygium of species of *Tanytarsus*: a, *T.* (*Microspectra*) *monticola*, sp. n. b, *T.* (*Lundströmia*) *bituberculatus*, sp. n. c, *T.* (*L.*) *laccophilus*, sp. n. d, *T.* (s. str.) *inopertus*, Walk. e, *T. gregarius*, Kieff. (with two forms of appendage 2*a*). f, *T. curticornis*, Kieff. (two specimens, showing variation in anal point). g, *T. eminulus*, Walk. (with variation in appendage 1). h, *T. holochlorus*, sp. n. (with variation in appendages 1 and 1*a*). i, *T. richmondensis*, sp. n. j, *T. reflexens*, sp. n. (anal point from above and from side, and appendage 2*a*). k, *T. arduennensis*, Goet. (= *gotchi*, Goet.). l, *T. photophilus*, Goet., var. ? (with outline of style in side view, and two forms of appendage 2*a*).

very long, segments 2 and 3 subequal in length. A.R. about 1·2, plume dark. Hypopygium (fig. 14*j*) remarkable for the structure of the anal point, which is rather long, with a reflexed appendage apparently hinged near its tip, apex of appendage forked into two small fleshy tentacles which can apparently fit into two small grooves on the surface of the tergite. Appendage 1 broad, with projecting tip, inner margin with two bristly hairs; 1*a* slender, its tip visible from above; 2*a* rather long, much enlarged apically and bearing a number of curved, flattened bristles or lamellae. Front tarsus without beard, L.R. 2·1–2·2. Outer spur of hind tibia longer and stronger than inner. R_1 more than two-thirds as long as R_{4+5}, which ends above tip of Cu_1. Wing-length 2 mm.

♀. Not much lighter than ♂; grey pruinescence on thorax equally distinct. Frontal tubercles absent. Antennae 5-segmented (first two and last two flagellar segments being fused), 5 nearly twice as long as 4.

Llyn Gwynant, Carnarvon and Gidleigh, S. Devon (*F.W.E.*); Kincraig, Inverness (*Grimshaw*).

T. richmondensis, sp. n. ♂♀. Differs from the last only as follows: thorax yellowish, scutal stripes scarcely darker; scape and postnotum sometimes slightly darkened; grey pruinescence of thorax less obvious. Abdomen entirely pale green. Legs pale. L.R. 2·4. Hypopygium (fig. 14*i*) practically as in *T. reflexens.*

Richmond, Surrey (*Gotch*); Temple Sowerby, Westmorland (*F.W.E.*); Newtown, N. Wales (*Miss Ricardo*).

Group C.

(*Rheotanytarsus*, Bause, Kieff.)

Combs distinctly separated, both spurred (inner spur longer than outer in the British species). No pulvilli or frontal tubercles. Wings rather densely hairy; *r-m* short; R_{4+5} ending just beyond level of tip of Cu_1; R_{2+3} apparently absent, R_1 and R_{4+5} running close together. Antennae of ♀ (*photophilus*) 7-segmented. Male with long simple anal point; apical third of styles suddenly narrowed and pointed.

Only one British species has so far been obtained as adult, but others probably occur; I have seen larval cases similar to those figured by Bause.

T. photophilus, Goet. Thorax all yellowish-green, abdomen pale green, legs pale. A.R. about 1; L.R. 1·75. The thin tip of the male styles is curved downwards, almost hooked. Shelford, Cambs., and Staveley, Westmorland (*F.W.E.*); Richmond, Surrey (*Gotch*); Dovedale and Dolgelley (*Verrall*).

There is much variation in the length of appendage 2*a* (see fig. 14*l*) and the number and width of the lamellae it bears at its tip. Possibly there may be more than one species.

Group D.

(*Tanytarsus*, s. str.)

Combs of posterior tibiae well separated, each occupying less than a quarter of tibial circumference; outer comb with a longish spur, inner often with a shorter and more slender spur, or unarmed. No distinct pulvilli. Wings more or less densely hairy on apical half, hairs always fairly numerous in cell Cu_1 in ♂. R_{2+3} fairly distinct and ending near midway between tips of R_1 and R_{4+5}, these veins well separated; R_{4+5} ending about opposite tip of Cu_1; *r-m* always short. Male styles not suddenly narrowed near tip. L.R. usually 2 or more. Antennae of ♀ usually (perhaps always) 5-segmented (2–3 and 6–7 being fused).

Of this group I have material of 16 British species, which can be divided into two series on the form of the anal point of the male. Unfortunately the character which I use has not been noted by Goetghebuer, and it is not always possible to decide in which series some of his species belong.

Series 1.

Anal point of ♂ with a longitudinal row of dots (usually single, rarely irregularly double) placed between two keels, as in *T. gregarius* and *T. lugens*. Frontal tubercles usually present.

T. holochlorus, sp. n. ♂. All green; legs and halteres pale; scape and mouth-parts sometimes dark (? discoloured). Frontal tubercles rather large. A.R. about 1·5. Appendage 1 (fig. 14*h*) twice as long as broad, narrowed apically, with two or three long hairs on inner margin; 1*a* slender, curved; 2 swollen apically; 2*a* rather short with some simple and some flattened hairs, as in *T. gregarius*. Front tarsus with short but distinct beard; L.R. 2·2. Spurs both well developed, inner slightly longer than outer. Wings faintly purplish by transmitted light; anal cell almost bare, but hairs in cell *M* numerous and reaching back to cross-vein or beyond. R_{2+3} ending rather near R_1. Wing-length 3 mm. Mitcham, Surrey, and Witherslack, Westmorland (*F.W.E.*).

This is evidently related to *T. cornutus*, Goet.; which, however, is said to have A.R. 1·0, and scutal stripes black.

T. ejuncidus, Walk. (*brayi*, Goet.). Differs from the last in having the frontal tubercles more slender, though quite distinct (they were not mentioned by Goetghebuer); A.R. about 1·2; L.R. 2·4; no front tarsal beard; appendage 1 not narrowed apically. Wing-length about 2·5 mm. Llangollen (*Verrall*) and Radwell, Herts (*F.W.E.*); one ♂ from each locality, agreeing well with Walker's type and with Goetghebuer's figure of *T. brayi*.

T. eminulus, Walk. The type is a ♀ and therefore not precisely determinable, but I propose to use the name for a species which closely resembles *T. ejuncidus* except in having appendage 1 of hypopygium shorter and more or less oval, 1*a* relatively longer (fig. 14*g*); L.R. 2·4–2·7. Slapton, S. Devon (*Verrall*); Richmond, Surrey (*Gotch*); Beaulieu, New Forest, and Hale, Westmorland (*F.W.E.*).

T. arduennensis, Goet. (*gotchi*, Goet.). ♂. Light green; scutal stripes more or less darkened, lateral stripes (in the specimens before me) ending posteriorly in a darker dot; postnotum rather dark brown, pale at base. Frontal tubercles small. A.R. about 1·0, L.R. 2·2. Wings with brown tinge by transmitted light; hair more scanty than in last three species, row of hairs in cell *M* not nearly reaching back to cross-vein. Wing-length 2 mm. Richmond, Surrey (*Gotch*).

Goetghebuer's figure of *T. gotchi* was prepared from a badly mounted and rather distorted specimen which I sent to him. I have remounted the same specimen and give a fresh figure (fig. 14*k*), from which it will be seen that *T. gotchi* has the same structure as *T. arduennensis*, except that the row of dots on the anal point is not shown in Goetghebuer's figure of the latter. A second specimen from Richmond was determined by Goetghebuer as *T. arduennensis*.

T. verruculosus, Goet. (?). ♂. All green. Frontal tubercles absent (?). Row of hairs in cell *M* extending back beyond cross-vein. Otherwise as in the last. Radwell, Herts., 1 ♂ (*F.W.E.*).

T. lestagei, Goet. ♂. Olive-green; scutal stripes shining black and almost fused; postnotum, sternum and sometimes scutellum black; legs somewhat darkened. Frontal tubercles rather small (overlooked by Goetghebuer). Appendage 2*a* of hypopygium ending in a large brush of simple yellowish hairs. Wings scantily haired, hairs in cell *M* not reaching cross-vein. Levenshulme, Manchester, and Poynton, Cheshire (*Britten*); Windermere and Stickle Tarn, Westmorland (*F.W.E.*).

T. curticornis, Kieff. ♂. Light green; scutal stripes and postnotum yellowish to brown; legs pale. Frontal tubercles absent. A.R. about 0·8. L.R. 2·0. Appendage 1*a* with a somewhat kidney-shaped or pyriform enlargement apically; 2*a* very minute, scarcely distinguishable in some specimens (fig. 14*f*). Wings rather scantily haired, hairs in cell *M* not reaching cross-vein. Richmond (*Gotch*); Harlesden, Mx. (*Austen*); Dolgelley (*Verrall*); Newtown, N. Wales (*Ricardo*); Llyn Gwynant and Windermere (*F.W.E.*). Determined by comparison with a specimen named by Kieffer and received from Thienemann.

A variety is olive-green, with scutal stripes and postnotum black. Correin Lochan, Arran (*F.W.E.*).

Series 2.

Anal point of ♂ usually longer, without row of dots or dorsal keels. Frontal tubercles usually (perhaps always) absent.

T. signatus, v.d.W. (*bicinctus*, Goet., ? *bipunctatus*, Kieff.). Green; middle scutal stripe, margins of scutum posteriorly, abdominal segments 3 and 7, knees, tips of tibiae and knob of halteres black. Corrour, Inverness (*Grimshaw*); Arran, Windermere, Gormire (Yorks.), Killarney (*F.W.E.*); Cambridge (*Jenkinson*). This is strikingly distinct from all other species of the genus in colouring, but exhibits no peculiarities of structure.

T. pallidicornis, Walk. (*subaequalis*, Goet.). ♂. Light green; scutal stripes and postnotum yellowish or reddish (Goetghebuer says dark brown); legs light brownish. L.R. 1·9–2·0. Front tarsus with short but distinct beard. Appendage 1 oval; 1*a* slender, curved; 2*a* short, with simple hairs. Wings faintly purplish by transmitted light, scantily haired, anal cell almost bare. Llandwrog, Carnarvon and Shefford, Beds. (*F.W.E.*).

A variety is olive-green, with scutal stripes and postnotum black; L.R. 1·7. Oxford (*Hamm*); Wood Walton, Hunts., and Hauxton, Cambs. (*F.W.E.*).

T. junci (Mg.) Goet. (*semivillosus*, Goet.). ♂. Similar to the last, but anal point differently formed, appendage 1 shorter, 1*a* stouter and more prominent. Colour similarly variable. Knebworth, Herts., and Stickle Tarn, Westmorland (*F.W.E.*).

T. verralli, Goet. ♂. Clear grass-green; scape, scutal stripes, postnotum and sternum dark brown to black; legs and antennal plume brownish. A.R. about 1·3; L.R. 1·8. Front tarsus with slight beard. Wings without brown tinge; hairs in cell *M* reaching back to cross-vein. Hypopygium (fig. 15*a*.); Anal point very slender; on dorsal surface of tergite well behind the point is a small group of four longish hairs.* Appendage 1 much broader than long, strongly emarginate on inner margin, one of the points with two short bristles; 1*a* not very stout and slightly projecting, 2 somewhat bilobed at tip, 2*a* projecting inwards, with a small tuft of almost simple hairs at its tip.

* These hairs are shown much too short in the figure.

♀. Scutal stripes, etc., yellowish. Wings more hairy than in ♂. Wing-length 2·7 mm.

Slapton, S. Devon (*Verrall*); Ruislip, Mx. (*F.W.E.*). Goetghebuer's figure is not quite accurate; I therefore give a fresh drawing of the type.

T. samboni, sp. n. ♂. Similar to the last, but A.R. 1·1–1·2; L.R. 1·9; no tarsal beard; appendage 1 not so broad and not definitely emarginate on inner margin; 1*a* much stouter; 2 not bilobed apically, 2*a* shorter (fig. 15*b*). Colwich Park, Staffs. (*Verrall*); Windermere (*F.W.E.*).

I have pleasure in dedicating this species to Dr. L. W. Sambon, through whose kindness I was enabled to make extensive collections in Windermere during the past summer.

T. lactescens, sp. n. ♂. Pale green; scape, postnotum and sternum black; scutal stripes shining black and almost fused, remainder of mesonotum brownish; legs, antennal plume and halteres whitish. A.R. about 0·8, last few joints indistinct. L.R. 2·2. Wings rather milky (faintly brownish by transmitted light), hair very scanty, the row in cell *M* not nearly reaching cross-vein. R_1 scarcely more than half as long as R_{4+5}. Hypopygium (fig. 15*c*) much as in the last, but appendage 1 emarginate on inner margin. Wing-length 1·6 mm. Quy, Cambs. (*F.W.E.*).

This is possibly a variety of *T. heusdensis*, Goet.

T. excavatus, sp. n. ♂. Scape and thorax shining black; abdomen clear green; antennal plume and legs brownish; halteres white. A.R. about 1·3; L.R. 2·1–2·2. Wings not milky (faintly purplish by transmitted light); hair in cell *M* reaching back beyond cross-vein. R_1 two-thirds as long as R_{4+5}. Hypopygium (fig. 15*d*). Ninth tergite without the dorsal group of hairs seen in the last three species. Appendage 1 very deeply excavated on inner margin, the two points bordering the excavation about equal in length, proximal bearing two bristles; 1*a* finger-like; 2*a* with very short bare stem ending in two lamellae. Wing-length 2·5 mm. Castle Howard, Yorks. (*F.W.E.*); Newtown, N. Wales (*Miss Ricardo*).

I had at first confused this species with *T. laetipes*, to which it bears a close superficial similarity; apart from the differences in tibial combs and hypopygium, the present species may be distinguished by the slightly darkened legs and longer front tarsi.

T. nemorosus, sp. n. ♂. Scape black; thorax clear pale green, scutal stripes and postnotum scarcely darkened; abdomen pale green; antennal plume and legs light brownish; halteres whitish. A.R. about 1·3. Front tarsi broken. Wings as in the last species. Hypopygium (fig. 15*e*) almost as in the last species, but appendage 1 rather differently shaped, its distal point shorter; 2*a* with three lamellae. Wing-length 2·5 mm. Epping Forest (*F.W.E.*).

This is possibly to be regarded as a green variety of the last, from which it hardly differs except in the colour of the thorax.

T. glabrescens, sp. n. ♂. Pale green; scutal stripes shining black and well separated; scape, postnotum and sternum black; legs and halteres whitish; antennal plume brownish. A.R. about 1·0. L.R. 2·0, front tarsi without beard. Wings milky (brownish by transmitted light), hairy at tip only; a single row of hairs extending back to just before middle of cell R_5, row in cell *M* even shorter, very few hairs in cell Cu_1. R_1 just over half as long as R_{4+5}. Hypopygium (fig. 15*f*) with very long anal point; appendage 1 with a large prominence on inner margin distally; 1*a* almost covered by 1; 2*a* very slender, projecting inwards at right angles to axis of body, with a

few simple hairs at tip. Wing-length 1·8 mm. Brothers' Water, Westmorland (*F.W.E.*).

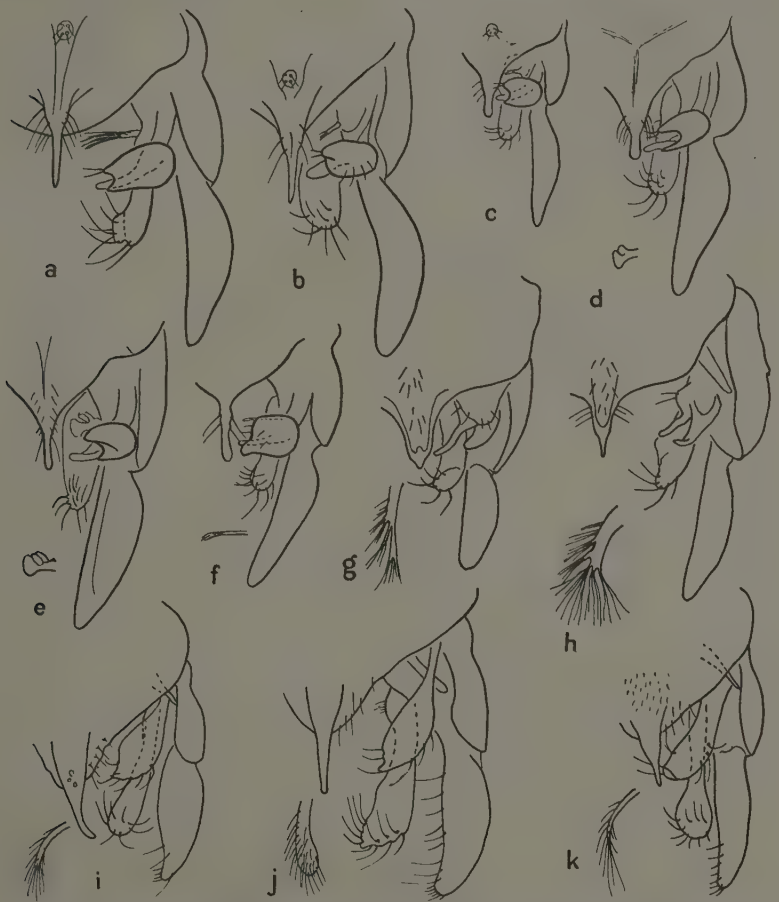

Fig. 15.—♂ Hypopygia of species of *Tanytarsus*: right half, from above, with appendage 2*a* shown separately. a, *T. verralli*, Goet. b, *T. samboni*, sp. n. c, *T. lactescens*, sp. n. d, *T. excavatus*, sp. n. e, *T. nemorosus*, sp. n. f, *T. glabrescens*, sp. n. g, *T. van-der-wulpi*, sp. n. h, *T. atridorsum*, Kieff. i, *T.* (*Stempellina*) *brevis*, sp. n. j, *T.* (*S.*) *saltuum*, Goet. k, *T.* (*S.*) *minusculus*, sp. n.

Group E.

Combs and venation as in Group D. Wings hairy at the extreme tip only, no hairs in cells Cu_1 or *An* (at least in ♂). Few or no hairs on R_1 and R_{4+5}, none on *Cu*. No frontal tubercles; no pulvilli. A.R. fully 2. L.R. 1·2.

This group includes only one British species, which is very distinct, although with a strong superficial resemblance to the subgenus *Lauterbornia*. In the

type of *Lauterbornia* (*L. koenigi*, Kieff. = *coracina*, Kieff. *nec* Zett.; a species which may be expected to occur in Scotland), the wings are similar to *T. sylvaticus*, but the L.R. is only 1·0, the tibial combs are practically fused and without spurs, and the tarsal beard is much longer.

T. sylvaticus (v.d.W.), Goet. A large black species with ♂ front tarsi bearded; it might be confused with *Pentapedilum coracinum*, but is readily distinguished by the bare squama and structure of hypopygium. Levenshulme, Manchester and Rostherne, Ches. (*Britten*); Sherwood Forest (*Carr*); Burnham Beeches, Bucks. (*F.W.E.*).

Group F.

(*Cladotanytarsus*, Kieff.)

Combs and venation as in Group D. Wings of ♂ hairy only at extreme tip, normally no hairs in cell Cu_1, nor on veins, except at tip of *M* and on costa. No frontal tubercles or pulvilli. A.R. under 1·5. L.R. 1·7 or more. Male styles rather short, not narrowed at tip; appendage 2*a* long, with branched hairs. Antennae of ♀ 5–6 segmented (2 and 3 sometimes separate, 6 and 7 fused).

T. mancus, Walk. (*modicellus*, Walk.; *nigrovittatus*, Goet.). Green; scutal stripes in ♂ separate and either red (*mancus*, type; var. *rufovittatus*, Goet.), black, or median stripe red and laterals black; scape, postnotum and sternum black. L.R. 1·7. Appendage 1*a* very long. Wings rather milky, 2·5 mm. long. Slapton, S. Devon (*Verrall*); Christchurch (*Miss Ricardo*); Shelford, Cambs. (*F.W.E.*); also specimens without locality determined by Walker as *Ch. rufovittatus*, Staeg. and *Ch. pusillus*, L.

T. atridorsum, Kieff., 1924*c* (*olivaceus*, Goet.). ♂. Thorax almost entirely shining black; shoulders and pleural patch more or less greenish; abdomen olive-green; legs darkened. L.R. 1·85. Wings without milky tint, 2 mm. long. Hypopygium (fig. 15*h*) almost as in *T. mancus*, but appendage 1*a* shorter (Goetghebuer's figure of *olivaceus*, based on a British specimen, is quite inaccurate as regards the appendages). ♀. Light green; scutal stripes light brownish or absent. L.R. 1·5. Wings rather more hairy, a number of hairs in cell Cu_1 and on branches of *Cu*. Rather common.

T. van-der-wulpi, sp. n. (Verrall MS.). ♂. Light green; scutal stripes blackish but well separated; scutellum green; antennal plumes, legs and halteres whitish. A.R. about 0·8. L.R. 2·2. Hypopygium (fig. 15*g*) similar in type to the last two, but styles shorter. Wings (Plate XIX, fig. 16) with a very distinct milky tinge; hairs even less numerous than in the last species, the row in cell R_5 being shorter. Venation almost as in the last species, but R_{2+3} ending a little nearer R_1. Wing-length about 2 mm.

Dovedale, Derbyshire, and Bewdley, Worcester (*Verrall*). A variety from the New Forest (*Ricardo*) differs in having the scutal stripes light reddish.

Subgenus **Phaenopelma,** Kieff.

Combs of posterior tibiae small and well separated, but without spurs. Small pulvilli present. Antennae of ♂ 13–14 segmented, of ♀ 6-segmented (2 and 3 fused, 6 and 7 separate). Wings with rather scanty hair on outer half, and very narrow, with anal area much reduced; *r-m* moderately long; R_{4+5} ending above tip of Cu_1; *fCu* only slightly beyond base of *Rs*; fringe not very long. Scutellum with several long marginal hairs.

One British species is referred doubtfully here; it is evidently not closely related to the type (*fuscicauda*, Kieff.).

T. (P.) intricatus, Goet. Green; scape, scutal stripes and postnotum black in ♂, dark brown in ♀. L.R. only 1·25. Appendage 1*a* double, 2*a* rather long, with numerous lamellae. Wing-length 1·5–1·8. Offley, Herts. (*F.W.E.*).

Subgenus **Zavrelia,** Kieff.

Eyes pubescent. Antennae of ♂ with only 11 distinct segments, of ♀ with 5 segments. Small frontal tubercles present. Scutellum with several marginal hairs. Appendage 1*a* of hypopygium absent. Combs of posterior tibiae small, separate, one comb with slender bristly spur, the other unarmed. No pulvilli. Wings cuneiform, without anal angle; fringe long. R_{4+5} ending distinctly before level of tip of Cu_1.

One British species; it is in many respects similar to the species of the subgenus *Stempellina*.

T. (Z.) nigritulus, Goet. Black. Wings narrow; pubescence almost confined to apical third; R_1 at least three-quarters as long as R_{4+5}. Wicken and Epping (*F.W.E.*).

Subgenus **Stempellina,** Bause.

Eyes bare. Antennae of ♂ with only 11 distinct segments, traces of two more joints usually distinguishable, making 13 segments in all; of ♀ with 5–6 segments, last two sometimes fused, in which case the last segment bears a verticil; when 5 and 6 are separate 5 is without neck and 6 without verticil. Small frontal tubercles present. Scutellum with two long bristly hairs placed close together at apex, other hairs (if present) short and inconspicuous. Appendage 1*a* of hypopygium absent. Combs of posterior tibiae small, separate, one comb with slender spur, the other unarmed. Wings without anal angle; fringe long. R_{4+5} ending before or above level of tip of Cu_1.

This subgenus includes a few very small species which resemble *Zavrelia*, not only in the adult but also in the case-bearing habit of the larvae. Kieffer referred here only to the genotype, *S. bausei*, which has distinct pulvilli; Goetghebuer (quite rightly, in my opinion) added *T. saltuum*, which has no pulvilli. These two species may be taken as typifying two rather distinct groups of the subgenus, both of which occur in Britain.

Group A.

(*bausei*-group.)

Pulvilli present, about half as long as claws. Male styles long, narrow and pointed. R_{4+5} ending well before level of tip of Cu_1.

T. (S.) bausei, Kieff. ♂. Thorax green, scutal stripes, postnotum and sternum black; abdomen dull green; legs brownish. A.R. about 0·9 (if only 11 segments are counted, about 1·25). Hypopygium almost as figured by Goetghebuer, but appendage 1 not so stout. Wings practically without trace of anal angle. R_1 almost three-quarters as long as R_{4+5}. Row of hairs in cell R_5 extending back only as far as middle of Cu_1.

♀. Entirely green. Shape and pubescence of wings as in ♂, but R_1 not quite two-thirds as long as R_{4+5}. Barton Hills, Beds. (*F.W.E.*).

T. (S.) bausei, var. ? Resembles *T. bausei* as determined above, but

abdomen of ♂ clear pale green; appendage 1 of hypopygium still narrower, and wings slightly broader, with anal angle just indicated. Killarney and Windermere (*F.W.E.*).

GROUP B.

(*saltuum*-group.)

Pulvilli absent. Male styles shorter and less pointed, and usually the whole male abdomen relatively shorter than in Group A. R_{4+5} ending above tip of Cu_1. Wings without trace of anal angle.

T. (S.) brevis, sp. n. ♂. Rather dull green; scutal stripes distinctly separate, dark brown to blackish; postnotum and sternum black; scutellum greenish; abdomen darkened dorsally; legs brownish; antennal plume dark. A.R. about 0·5 (or, reckoning 11 segments, 0·9), segments 8–10 over twice as long as broad. L.R. about 1·6. Hypopygium (fig. 15*i*) with appendage 1 narrow at base, 2 scarcely swollen apically, 2*a* long and slender; styles short and rather thick, with slightly bent tip. Wings (Plate XIX, fig. 17) rather densely hairy at tip (beyond costa), also with a single row of hairs extending nearly to base of cell R_5, and another extending almost to base of wing between *M* and *Cu*; all veins hairy, including Cu_1. R_1 not quite two-thirds as long as R_{4+5} (45 : 75); cubital fork not very wide, *An* almost reaching its base. Wing-length 1·3–1·5 mm.

♀. Entirely green. Wings much as in ♂ in regard to shape and hairiness; R_1 slightly shorter, but over half as long as R_{4+5}. Antennae distinctly 6-segmented, 6 almost as long as 4 and with a few short hairs at tip.

Sannox and Catacol, Arran; Windermere and Brothers' Water, Westmorland; Killarney (*F.W.E.*); Corrour, Inverness (*Grimshaw*); Goyt Valley, Cheshire (*Britten*).

This is allied to *T.* (*S.*) *saltuum*, Goet., but quite distinct. Males of *T. saltuum* sent me by Goetghebuer show the following differences :—Size rather larger than *T. brevis*. Wings still narrower and rather more hairy, the row of hairs in cell R_5 being double, except towards base. R_1 rather longer, fully two-thirds as long as R_{4+5}. A.R. 1·3 (reckoning 11 segments). Appendage 2*a* of hypopygium (fig. 15*j*) much stouter and with shorter pubescence (this is not indicated in Goetghebuer's figure of *T. saltuum*, which might almost serve for *T. brevis*).

T. (S.) flavidulus, sp. n. ♂. Very similar to *T. brevis* in antenna, hypopygium and wings, differing chiefly as follows : Scutal stripes in contact, though the prescutellar area and scutellum are hardly darkened. Abdomen pale yellowish-green. Appendage 1 differing very slightly in shape, but 2 not more clubbed; anal point rather shorter. Legs whitish. Antennal plume very pale, almost white. Row of hairs between *M* and *Cu* not extending back beyond *r-m*. Wing-length 1·3 mm.

♀. Entirely pale yellow, not green even in life. Pubescence of wings as in ♂; venation and antennae as in ♀ of *T. brevis*.

Barton Hills, Beds., 4 ♂♂ 1 ♀ (*F.W.E.*).

T. (S.) minor, sp. n. ♂. Very similar to the last two. Scutal stripes more or less completely fused; prescutellar area and scutellum darkened, in one specimen quite black. Abdomen dark olive-green. A.R. about 1·3 (reckoning 11 segments). Appendage 1 not much narrowed at base, 2 more swollen at tip, 2*a* very slender (fig. 15*k*). Wings rather less hairy than in *T. brevis*, the row of hairs between *M* and *Cu* not reaching back beyond base

of cubital fork, this fork more widely open. *An* not nearly reaching *fCu*. R_1 relatively longer, almost three-quarters as long as R_{4+5} (36 : 50). Wing-length 1·3 mm.

♀. Green. Scutal stripes scarcely indicated. Wings much as in ♂, but R_1 slightly shorter. Antennae as in *T. brevis*.

Newtown, N. Wales, 30.viii.1893, 2 ♂♂ (*Miss G. Ricardo*). Windermere, 1 ♂ (*F.W.E.*); Levenshulme, Manchester, 2 ♂♂ 1 ♀ (*Britten*).

T. (S.) cuneipennis, sp. n.

♀. Dull olive-green; scutal stripes, postnotum and mesosternum black; head, scutellum, and legs dark. Antennae 5-segmented, the 4 flagellar segments subequal in length, first a little enlarged in middle beneath, last segment with verticil before middle and a very few short apical hairs. Frontal tubercles very small. L.R. about 1·6. *Wings* (Plate XIX, fig. 18) differing from the last three in shape and venation: hind margin not evenly rounded but with an enlargement near tip of Cu_2, where wing is broadest; R_1 much shorter, hardly more than one-third as long as R_{4+5}. Wing also somewhat less hairy; the line of hairs between *M* and *Cu* extends back only a short distance, not nearly to *r-m*; no hairs on Cu_1. Cubital fork rather widely open; *An* not nearly reaching base of fork, and with very few hairs. Wing-length 1·1 mm.

Letchworth, Herts., vii.1917, 1 ♀ (*F.W.E.*).

This specimen can hardly be the female of *T. saltuum*, the only species of this group of which I do not know the female. Any sexual difference in hairiness of the wing should be in the direction of increase of hairiness in the female, and though some shortening of R_1 occurs in the females of various Chironomidae, the difference is never so marked as in the present instance.

T. (S.?) sp. inc. ♀. All yellowish-green. Wings rather more hairy than in the last but somewhat similar in shape. L.R. 2·5. Quy, Cambs. (*F.W.E.*).

Literature.

The following is not a complete bibliography, but includes most of the recently-published papers in which adults of European Chironomidae are described or discussed. Only some of the more important of the papers dealing solely with early stages are mentioned; a list of these will be found in Spärck's paper.

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Appendix.

I take this opportunity of correcting a few errors in my paper on the British Biting Midges (*Trans. Ent. Soc.*, 1926). These were mostly due to the fact that I was unable to see the proofs owing to absence from England. A few additional records and notes are also appended.

P. 390. In the list of family characters of Ceratopogonidae, to "Postnotum gently rounded," add "without median furrow or keel." To the character of Chironomidae, "Postnotum more prominent," add "generally with median furrow or keel."

P. 391. The word "Tanypodidae" should read "Tanypodinae."

P. 399. The last two of the three characters given for the subgenus *Kempia* should be omitted. I had at first intended to recognise a third subgenus, *Gymnohelea*, with modified sixth sternite and bare wings in ♀, but finally decided to include it in *Kempia*, omitting to make the correction in the diagnosis.

P. 401. The generic name *Dasyhelea* must be replaced by **TETRAPHORA,** Philippi (1865). The original description and figures (especially of the female antenna) leave very little doubt that Philippi's type was a *Dasyhelea*, and specimens (probably belonging to the genotype, *T. fusca*) which I collected in 1926 confirm this determination.

P. 402. Dr. Goetghebuer states that in *D. holosericea*, Mg., the wing-hair is white, whereas in *D. pratensis*, Goet., it is black. I have not seen British specimens in which the wing-hair is definitely white, and our species should probably be named *D. aestiva*, Winn.

No locality was given for *D. notata*, Goet. I have seen only two British specimens, 1 ♀ from Shotover, Oxford (*Hamm*), and 1 ♀ from Brothers' Water, Westmorland (*F.W.E.*).

Thienemann states (1928) that there are pupal differences between *D. sensualis*

and *D. bilineata*; if so, one or other of these names should probably be omitted from the synonymy of *D. dufouri*. I omitted to note that in the specimens determined as *D. dufouri* the abdomen has the posterior margins of the tergites narrowly but distinctly whitish, as described by Winnertz for *D. versicolor*, whereas in all our specimens of the species recorded as *D. versicolor* the tergites are completely black, unless at the posterior corners; it is therefore doubtful if the latter species was correctly determined. The following appears to be distinct from either of the two British species of this group previously recorded :

Tetraphora saxicola, sp. n. Structural characters (antennae, hypopygium, wings) almost exactly as in *T. dufouri* and *T. versicolor*, but body almost completely blackish; no yellow colour on humeri or scutellum in either sex, and even the pleural membrane dark brownish; halteres almost entirely blackish, apex of knob obscure yellowish in ♀. Thorax with strong bluish-grey reflections forming an irregular pattern; as seen from in front there are no distinct stripes, and the shoulders are more finely mottled than in the other two species, with a dark spot at the base of each hair. Scutellum with about 10 marginal bristly hairs, and numerous dorsal hairs, irregularly arranged. Legs dark; front femora with an indistinct pre-apical pale ring; front tibia unicolorous; tarsi somewhat lighter. Wing-length 2·2–2·5 mm.

Westmorland : top of Whitbarrow down, Witherslack, vii.1929; 2 ♂♂ 3 ♀♀ reared from larvae found in water in small holes in rocks (*F.W.E.*). Other specimens, apparently of the same species, were sent me by Prof. Zavrel in 1928, obtained from larvae found in rock-holes.

Several other British species of *Tetraphora* await determination.

P. 404. *Culicoides nubeculosus*, Mg., might be placed under heading 2 of the key, as the wing-hair is rather scanty, especially in the ♂.

An additional locality for *C. stigma* is Keighley, Yorks. (*Wood*).

P. 405. I sent a number of British specimens of *Culicoides obsoletus*, Mg., to Dr. F. M. Root, who informs me that from his examination of the hypopygia there appear to be two if not three species represented under this name; one of these is, as I supposed, identical with the North American *C. sanguisugus*, Coq.

Additional localities for *C. heliophilus*, Edw., are : Glengariff (*Yerbury*); Killarney, Windermere and Epping Forest (*F.W.E.*); Upton, Norfolk (*Collin*). The species is not confined to hilly regions, as I had supposed, but the observation that it bites chiefly in hot sun has been confirmed several times.

P. 406. An earlier name for *Culicoides winnertzi*, Edw. (*pictipennis*, Winn.), is **C. odibilis,** Austen, the type of which is in the British Museum from Palestine.

P. 407. Dr. Goetghebuer believes that *Culicoides impunctatus*, Goet., is a distinct species.

P. 408. Add the following species of the subgenus *Ceratopogon* :

C. communis, Mg. Entirely dull black; humeral pits rather small. Eyes distinctly pubescent. Differs from the other three species in having the halteres dark brown (Goetghebuer says brownish-white) instead of pure white or pale yellow. Wings less conspicuously milky than in the other species, and considerably narrower, in the ♂ narrower than in the ♀ (figured by Goetghebuer), the anal angle very little developed. Hypopygium very much smaller than in *C. niveipennis*, and somewhat resembling *C. sociabilis*. Windermere, 20.iv.1922, 1 ♂ (*A. Dixon*). Epping Forest, 21.v.1929, 1 ♀ (*F.W.E.*).

In the ♂ there are no macrotrichia on the wing-membrane; in the ♀ a very few round the apical margin.

C. crassinervis, Goet., has occurred at Windermere and Temple Sowerby, Westmorland.

P. 411. *Monohelea calcarata*, Goet., is better placed in the genus **Stilobezzia.** Mr. J. E. Collin obtained 2 ♀♀ which almost certainly belong to this species at Upton, Norfolk, 3.viii.1929. These agree with Goetghebuer's description of the ♂ in having the thorax shining black, two spines on first hind tarsal segment (one at base and

one at tip), and three on first front tarsal segment (one at base and two near tip). They differ from the description of the ♂ in having rather numerous macrotrichia at the tip of the wing in cells R_5, M_1 and M_2, and on the branches of the media; also in the somewhat cordiform fourth tarsal segment. The claws are as in *Stilobezzia*: each tarsus with one large claw bearing a small basal branch (sometimes regarded as a second claw, but it is probably not so). Hind femur and tibia blackish, not noticeably thickened (Goetghebuer did not mention whether this was the case in his male). Scutellum with only four or five strong marginal bristles. Microtrichia of wings scarcely distinguishable, much smaller than in the other species of *Stilobezzia*. Radial veins dark brown.

The specimen I recorded as *M. calcarata* evidently belongs to a distinct allied species, and I therefore describe it below.

Stilobezzia sharpi, sp. n. ♂. Thorax not at all shining (except on the rather large humeral pits) strongly dusted with brownish-grey. Scutellum with about eight marginal bristles. Hind femur much thickened, almost as in *Serromyia*, though without spines; hind tibia also somewhat thickened. First segment of front tarsus with 4 spines (second spine near middle), second segment also with an apical spine. First segment of hind tarsus with three spines (second beyond middle). Wings with a few macrotrichia at tip in cell R_5, but none on branches of media. Radial veins not darkened. Size rather larger (wing-length about 1·5 mm.). Otherwise as in *S. calcarata* (Goet.).

New Forest, type ♂ (*Sharp*); Killarney, v.1929, 1 ♂ (*F.W.E.*).

P. 412. Mr. O. W. Richards has shown me specimens of *Stilobezzia lutacea*, Edw., from the Scilly Is.

P. 413. In the ♂ of *Neurohelea luteitarsis* the radial cells are shorter and the costa much less distinctly produced than in the ♀; the antennae are almost devoid of plume-hairs.

Clinohelea unimaculata was common at the Wake Valley Pond, Epping Forest, in July 1929. In the ♂ the dark cloud over the first radial cell is only faintly indicated.

P. 414. Add the following species of *Johannsenomyia*:

J. munda (Lw.) (*dentata*, Kieff.). Differs from the other three British species in having the knob of the halteres yellowish instead of black, and the wings distinctly milky-white, all the veins whitish. Antennae of ♀ entirely black and much shorter than in *J. nitida*, segments 10–14 each scarcely more than twice as long as broad. Thorax less brightly shining than in *J. nitida*. Abdomen somewhat yellowish at base. Legs as in *J. nitida*. Second radial cell a little shorter than in *J. nitida*, distinctly less than three times as long as the first and ending scarcely beyond tip of Cu_2. Base of median fork only just before *r-m*. Poynton, Cheshire, 6.vi.1927 (*Britten*).

The milkiness of the wings of this species is not due to the absence of microtrichia, these being only a little smaller and denser than in *J. nitida*.

P. 416. Although all species of *Palpomyia* normally have two radial cells, it should be noted that abnormal specimens may occur in which the cross-vein R_2 is lacking on one or both wings. I have seen examples of such an occurrence in *P. distincta*, *P. fulva* and *P. lineata*. Such specimens are not easily to be distinguished from species of *Bezzia*.

P. 419. An additional locality for *Palpomyia luteifemorata*, Edw., is Melkinthorpe, Westmorland (*Britten*).

P. 421. An additional locality for *P. spinipes*, Mg., is Loch Fad, Bute (*Grimshaw*).

P. 422. A second specimen of *Palpomyia brevicornis* (from Brothers' Water, Westmorland) differs from the type in having three spines on the hind femur instead of only one.

P. 423. Dr. Goetghebuer informs me that *Bezzia spinifera*, Goet., is distinct from *B. flavicornis*, Staeg.

P. 425. *Bezzia nobilis* has the front tibiae black at the tip; front femur with 2–3 spines; wings rather milky, but less so than in *B. bicolor*.

Pl. XCI, fig. 8. The engraver unfortunately altered the figure by completing vein M_2 to match the other wings on the plate. The part of this vein which is shown faintly in the figure is not really present and was not shown in my photograph. On the other hand the fold running back from M_2 to the middle of the basal section of M is not shown sufficiently clearly in the figure.

Explanation of Plates XVII–XIX.

Plate XVII.

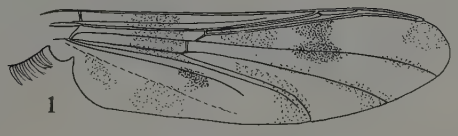
Wings of British Chironomidae.

Fig. 1. *Pentaneura northumbrica*, sp. n., ♂. (Hairs and fringe omitted.)
2. ,, *eximia*, sp. n., ♀. ,, ,, ,,
3. *Podonomus peregrinus*, sp. n., ♂. ,, ,, ,,
4. *Diamesa montium*, sp. n., ♂.
5. *Syndiamesa pilosa*, Kieff., ♂. Apex of wing.
6. *Prodiamesa olivacea*, Mg., ♂. Middle of wing.
7. *Brillia longifurca*, Kieff., ♂. ,, ,,
8. *Metriocnemus grimshawi*, sp. n., ♂.
9. ,, *subnudus*, sp. n.
10. ,, *tristellus*, sp. n., ♂.
11. ,, *penerasus*, sp. n., ♂.
12. ,, *cuneatus*, sp. n., ♀.
13. *Cardiocladius capucinus*, Zett., ♂.
14. *Spaniotoma* (*Psectrocladius*) *platypus*, sp. n., ♂.
15. ,, ,, *turfacea*, Kieff. ♂.
16. ,, (*Trichocladius*) *foveata*, sp. n., ♂.
17. ,, (*Orthocladius*) *dissipata*, sp. n., ♂.
18. ,, ,, *illimbata*, sp. n., ♂.
19. ,, ,, *xanthogyne*, sp. n., ♂.

Plate XVIII.

Wings of British species of *Spaniotoma*.

Fig. 1. *S.* (*Orthocladius*) *gracei*, sp. n., ♂.
2. ,, *apicalis*, Kieff., ♂.
3. ,, ,, ,, ♀.
4. ,, *tripilata*, sp. n., ♂.
5. ,, *minor*, sp. n., ♂.
6. ,, *flexuella*, sp. n., ♂.
7. *S.* (*Eukiefferiella*) *hospita*, sp. n., ♂.
8. ,, *camptophleps*, sp. n., ♂.
9. *S.* (*Limnophyes*) *gurgicola*, sp. n., ♂.
10. *S.* (*Smittia*) *cheethami*, sp. n.
11. ,, *ephemerae*, Kieff., ♂.
12. ,, ,, ,, ♀.
13. ,, *recta*, sp. n., ♂.
14. ,, *conjuncta*, sp. n., ♀.
15. ,, *angusta*, sp. n., ♂.
16. ,, *trilobata*, sp. n., ♂.
17. ,, *curticosta*, sp. n., ♂.
18. ,, *brevifurcata*, Edw., ♂.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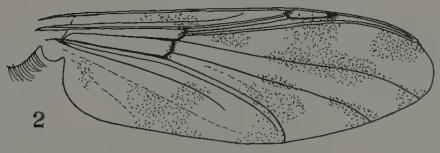
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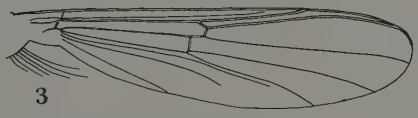
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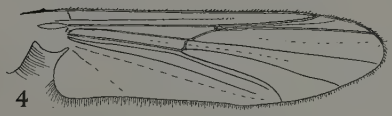
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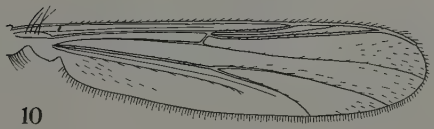
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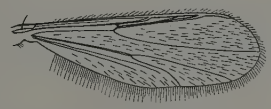
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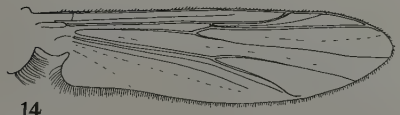
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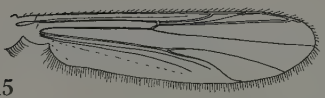
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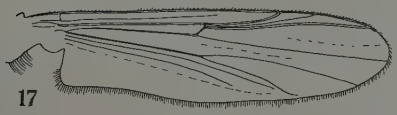
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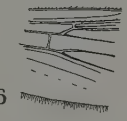
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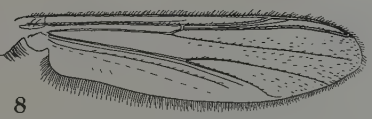
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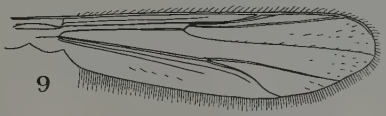
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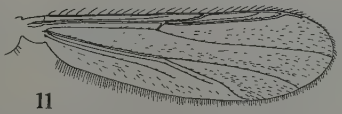
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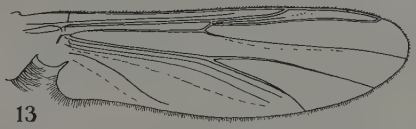
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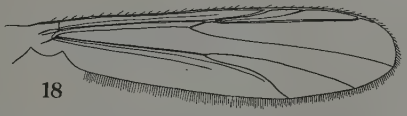
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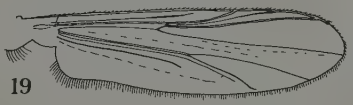
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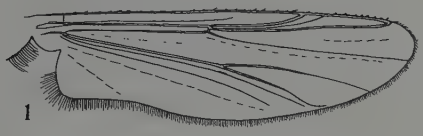
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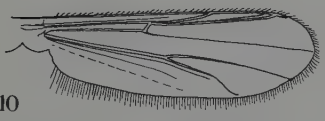
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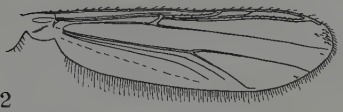
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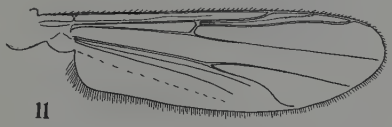
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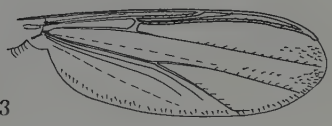
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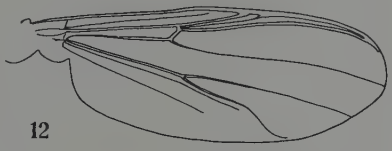
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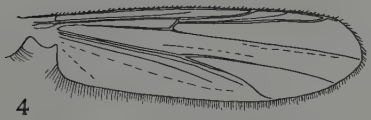
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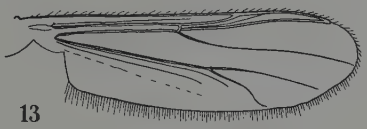
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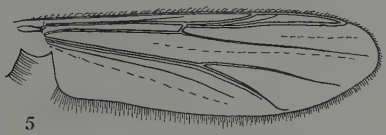
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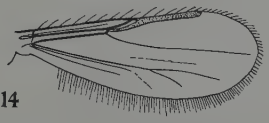
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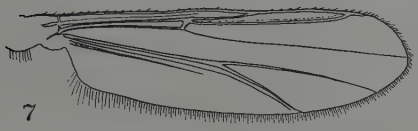
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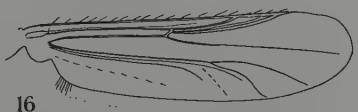
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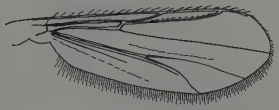
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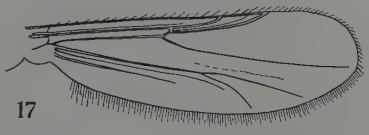
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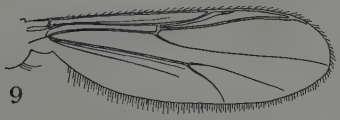
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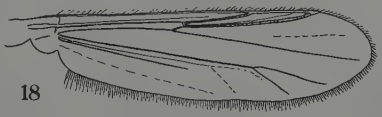
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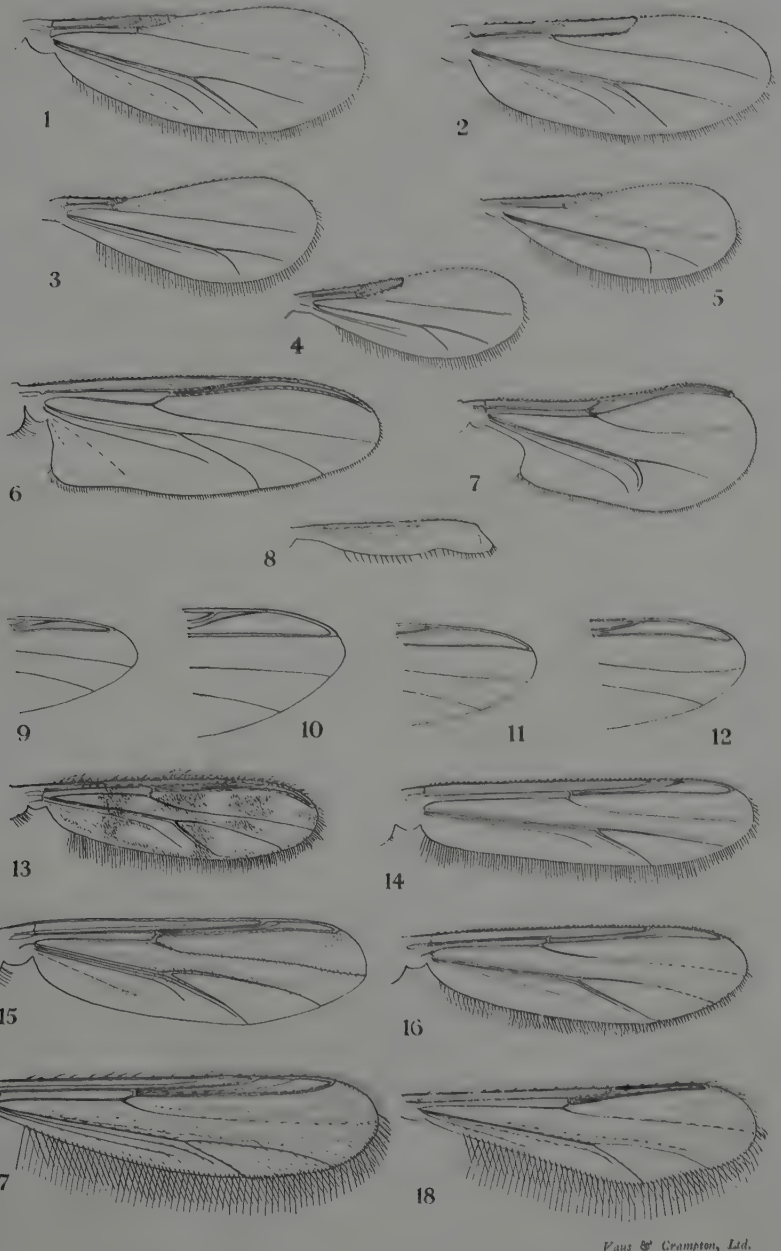
BRITISH NON-BITING MIDGES.



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BRITISH NON-BITING MIDGES.

Plate XIX.

Wings of British Chironomidae.

Fig. 1. *Corynoneura* (*Thienemanniella*) *flavescens*, sp. n., ♂.
2. ,, ,, *lutea*, Edw., ♀.
3. ,, (s. str.) *celtica*, Edw., ♂.
4. ,, ,, *fuscihalter*, sp. n., ♀.
5. ,, ,, *carriana*, Edw., ♂.
6. *Thalassomyia frauenfeldi*, Egg., ♂.
7. *Clunio marinus*, Hal., ♂.
8. *Psammathiomyia pectinata*, Deby, ♂.
9. *Pseudochironomus prasinatus*, Staeg. Tip of wing.
10. *Chironomus* (*Glyptotendipes*) *paripes*, sp. n. Tip of wing.
11. ,, (*Endochironomus*) *impar*, Walk. ,, ,,
12. ,, (*Microtendipes*) *confinis*, Mg. ,, ,,
13. ,, (*Polypedilum*) *apfelbecki*, Strobl, ♀.
14. ,, (*Lauterborniella*) *orophilus*, sp. n., ♂.
15. *Pentapedilum nubens*, sp. n., ♀. (Hairs omitted.)
16. *Tanytarsus* (s. str.) *van-der-wulpi*, sp. n., ♂.
17. ,, (*Stempellina*) *brevis*, sp. n., ♂.
18. ,, ,, *cuneipennis*, sp. n., ♀.

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[All generic names applied to recent European Chironomidae (excluding Ceratopogonidae) are noted. Synonyms in italics.]

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* The name *Pachycladius* has been used by Kieffer (1923c and 1924c) in connection with descriptions of two new species (*ellipsoidalis* and *longistylus*). No generic diagnosis appears to have been published, but from the descriptions of the species it may be deduced that Kieffer probably intended to distinguish *Pachycladius* from *Orthocladius* (s. str.) on the form of the front tibial spur, which is said to have a tooth on each side below the middle.

A CONTRIBUTION TO THE ETHOLOGY OF THE MELIPONINAE

By George Salt, D.Sc.

(Imperial Bureau of Entomology.)

[Read October 2nd, 1929.]

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Introduction and Acknowledgments.

In the course of a year spent in the Santa Marta region of Colombia I was able to devote a small part of my time to the collection and study of aculeate Hymenoptera. The common and ubiquitous stingless bees soon attracted my special attention, not alone on account of their numbers and variety, but more especially because their diverse nesting habits and highly developed social life offered great scope for ethological studies. However, with no literature on the subject available and only late afternoon and evening hours at my disposal, my early efforts were misguided and almost fruitless. It was not until nine months had passed that I thoroughly examined a meliponine nest; a clay structure occupied by a colony of *Melipona favosa*. From its comb I reared a Phorid fly. This circumstance, and the coincident receipt and perusal of a copy of W. M. Wheeler's "Les Sociétés d'Insectes," fired my enthusiasm, and during the remaining three months of my sojourn in Colombia I opened and examined as many nests as I could get.

The data thus obtained fall naturally into two parts, and are so presented in this paper. First are described the nests examined and the habits of the meliponine bees observed. These notes are offered for what they are worth without any attempt to correlate them with published facts or theories. The second part deals with the various Arthropods other than bees found in the nests; some are definitely melittophilous, others may have been only accidentally present. In this case, as no work of the same intent and scope has hitherto appeared, an effort has been made to bring together the available records from all parts of the world and to deal with the entire subject of melittophily so far as it concerns the stingless bees.

Such a varied fauna as that studied in the second part of this paper requires the co-operation of several specialists. I am deeply grateful to the following workers, whose aid has been invaluable:—first of all to Mr. H. F. Schwarz of the American Museum of Natural History, who has, with the utmost courtesy, determined all of my Colombian Meliponinae; to Mr. G. J. Arrow of the British Museum, Mr. G. E. Bryant of the Imperial Bureau of Entomology, and Dr. M. H. Hatch of the University of Washington for assistance with the Coleoptera; to Professor C. T. Brues of the Bussey Institution for determining the Phoridae; to Dr. H. Graf Vitzthum of Berlin for his work on the mites; and to Dr. J. C. Chamberlin of Stanford University for describing the new pseudoscorpion. Dr. J. W. Folsom kindly studied my poorly preserved Collembola, and Mr. Ellsworth P. Killip of the United States National Museum supplied all the plant names. My friends S. A. Svenningsen and W. F. McCardle gave willing and valuable assistance with the field work, and it was while enjoying the hospitality of Mr. M. A. Carriker at his beautiful mountain home at Vista Nieve that I was able to collect and study the mountain species. Dr. Joseph Bequaert of the Harvard Medical School and Dr. H. Eidmann of Munich both supplied me with interesting material; the former with the *Scotocryptus* from British Guiana, the latter with the interesting melittophiles from British East Africa. Finally I must record my gratitude to my former teacher, Dr. W. M. Wheeler, whose influence cannot fail to be apparent throughout the following pages.

PART ONE.

Notes on the Nests and Habits of Colombian Stingless Bees.

General Remarks.

Although the comprehensive accounts of Silvestri (1902) and von Ihering (1903) and numerous shorter papers by Poey, Müller, du Buysson, Schulz, Waterhouse and others have made known the principal features of the nests and habits of a good many species of Meliponinae, no complete treatment of the ethology of these bees has yet appeared.* Nor is the time yet ripe for such a work. Very few data are available on the habits of the Australasian forms; the African species are almost completely unstudied; and even in Central and South America, where a great deal of work has been done, a large proportion of the stingless-bee fauna remains ethologically unknown. The process of swarming and the foundation of new colonies has never been satisfactorily described. The problem of caste determination, though a matter of biological importance, is still unsolved. Of no single species can it be said that the life-history has been completely followed; while the organisms ethologically associated with stingless bees have received only the scantiest attention.

An adequate taxonomic treatment of the group is the first necessity for its ethological revision. Ducke's admirable studies have done much to establish the nomenclature of the Brazilian species, and the forthcoming monograph of Mr. H. F. Schwarz of the American Museum of Natural History may be expected to place the classification of the neotropical forms on a sound footing. When this is accomplished, it will be possible to deal with the existing literature in a comparative manner and remove many of the differences and contradictions with which it now abounds. Under the present conditions, however, such a revisional study is out of the question, and in this first part of my paper I have made no attempt to deal with the literature. I simply present my notes, practically as they were written in the field, on the nests and habits of the Colombian species I personally observed.

The first nest described below is very typical and so simple in form that it should not be necessary to give here an introductory account of the characteristic meliponine architecture. Mention must be made, however, of the materials used in the construction of the nest. The essential structural material of the stingless bees is wax, but this is rarely used in its pure state, and it is usually mixed with varying proportions of other substances to form the actual structural material known as *cerumen*. Propolis, resins, gums, and sticky plant exudates, soil, particles of wood, and especially clay are used with the wax to form cerumen, sometimes in such large proportions that the wax content is quite hidden. Cerumen is therefore a mixture of wax and one or more of these substances, and varies in colour, malleability, and hardness according to the nature and proportion of its constituents. Its composition is adapted to its immediate use; that which forms the honey- and pollen-pots and the brood cells is usually almost pure wax, the supporting pillars of the comb and provision pots are of harder cerumen but still plastic, the main structural supports are strong and stiff, while cerumen which forms in any way the outside wall of the nest is exceedingly hard and often largely composed of clay.

* Unfortunately, I have been unable to see a copy of the work of José Marianno, *Ensaio sobre as Meliponidas do Brazil*, Rio de Janeiro, 1911, 140 pp., 6 pl.

1. **Melipona interrupta,** Latr., var. **salti,** Schwarz.*

The first nest examined of this species, and that most carefully studied, was found near the town of Sevilla, Department of Magdalena, Colombia, on the 30th of July, 1927. It was built in the hollow trunk of a tree at a height of about 15 m. The original cavity of the tree had opened broadly in its upper part through a large gash in the side of the trunk (Pl. XX, fig. *a*.), but had been closed by the bees just below the bottom of the gash by a cerumen plug. This, the upper batumen, was about 4 cm. thick and composed of very hard cerumen, consisting largely of clay with some soil and small particles of wood.

The enclosed chamber thus formed (Pl. XX, fig. *b*.) was cylindrical, about 65 cm. long, and between 9 and 16 cm. in diameter. Its entire surface was coated with a thin, hard incrustation of black cerumen, which seemed also to impregnate and darken the surface of the wood. It could be entered only by a narrow vertical passage, about 2·5 cm. in diameter, through the upper batumen. The structures in the cavity were arranged in three sections. The uppermost, about 10 cm. long, contained a mass of waxen pots, all of which were filled with honey. In the next part, 25 cm. long, were situated twelve horizontal tiers of cells; the upper ones occupying practically the entire cross area of the nest, those below somewhat less of the space so as to accommodate a few pots of pollen placed at their sides. The lowest section, 30 cm. long, was packed with large pots, some containing pollen, others filled with honey.

The cerumen used in all the construction work was of a deep brown colour. Fastened to the side of the cell tiers in two or three places were small lumps, a cubic centimetre or a little more in bulk, of a somewhat gummy substance, probably wax mixed with propolis. These seemed to be stores of structural material.

The honey- and pollen-pots (Pl. XXI, fig. 2.) occupying the upper and lower parts of the nest were all similar, 4 to 6 cm. long and 3 to 5 cm. wide, generally oval in shape but not perfectly so. Their walls were of thin cerumen, except at the junction of two or three pots where they were sometimes of considerable thickness, and were supported and attached to the sides of the nest by short, stout pillars of slightly harder cerumen. The honey was clear, sweet, and stored in large quantities; this nest contained about two litres. The honey of this species is much esteemed by the inhabitants of the region, who, perhaps for this reason, speak of the bee as the "abeja real." The pollen ranged in colour from gamboge and yellow ochre to light brown, orange, and dull red. Usually each pot contained pollen of about the same basic colour, though sometimes there were small masses of other colours scattered in it. The odour of the pollen varied from pot to pot, probably differing, like the colour, with the flowers from which it was collected. All of it was very sour, and some so distinctly acid as to affect the membranes of the nose as fumes of vinegar. Some of it shaken up with a neutral-reacting water showed strongly acid with litmus paper. Probably the acidity serves to preserve it. The pollen was stored in a moist and malleable state and in large quantities. The total net weight of it in eleven pots was 246 gm., and the nest contained in the neighbourhood of 50 pots.

The central section of the nest, containing the brood, was enveloped in an irregular curtain of cerumen, the involucre. The horizontal tiers of cells (Pl. XXI, fig. 1.) were discoid, their area varying with the diameter of the chamber. They were supported one above the other and about 6 mm.

* This variety will be described in a forthcoming paper by Mr. H. F. Schwarz of the American Museum of Natural History.

apart by pillars of wax, and similar rods attached them to the curtain, pots, and walls of the nest. The individual cells were about 13 mm. long and 5·4 mm. wide, and when occupied by an egg or young larva contained a semi-liquid mixture of pollen and honey. By opening many adjacent cells containing adult or nearly adult bees it was readily established that males, females, and workers occur in neighbouring and similar cells indiscriminately mixed in the tiers.

While the part containing the nest was being cut out of the tree, the bees swarmed about in numbers, buzzing in an angry tone. They alighted on us, crawled into our clothes, and bit the bare skin, but only very feebly so that the work was not more than uncomfortable. Inside the nest was a single physogastric queen, several young females (about fifteen were noticed), numerous workers, and an unknown number of males. The latter are very similar in appearance to the workers, and it is not known whether they also were among the swarms which attacked us while the nest was being cut down. Wax scales were present on the dorsal surface of the abdomen of several of the workers. Bees continued to emerge from the comb in captivity; of twenty-five which appeared the fourth day after the nest was taken, thirteen were workers, seven males, and five females.

Several workers and some of the males found in the nest when it was first taken had their abdomens slightly swollen so that the sclerites were separated and the intersegmental membranes prominently displayed. In an attempt to understand this partial physogastry, several of the workers showing the abnormality were dissected, as well as normal males, females, and workers for comparison. It seemed in every case to be due simply to the distension of the crop, which was filled with honey, for I could find no sign of internal parasites or of developing eggs in any of the swollen workers. The ovaries of all workers dissected, swollen or normal, were very aborted, if indeed, they were found at all; but those of the young females were developed though not yet producing eggs. As both males and females are present together in the nest inbreeding would seem likely to occur.

The soil and refuse accumulated in the cavity of the tree above the upper batumen was inhabited by a colony of diminutive ants (*Wasmannia auropunctata*, Roger), whose galleries extended also into the rotting wood at the side. In addition, the debris contained four beetles, a Curculionid, two Scolytids, and a Pedilid, *Macratria* sp. None of these species, probably, was more than accidentally associated with the bees.

Inside the nest, however, were several Arthropods, some of which are undoubtedly melittophilous. An account of these is given in the second part of this paper; for the present it is necessary only to mention them. There were numerous examples of the mite *Hypoaspis meliponarum*, Vitzthum, and many of the pseudoscorpion *Dasychernes inquilinus*, Chamberlin. Representing the Coleoptera there were three specimens of the Staphylinid *Coproporus piceus*, Er., two individuals of the Cucujid *Silvanus trivialis*, Grouv., and a single example each of the Liodid *Scotocryptus meliponae*, Girard, and the Nitidulids *Colastus hilaris*, Murr., and *Haptoncus luteolus*, Er. Adults of the Phorid fly, *Pseudohypocera nigrofascipes*, Borg., were observed on the nest structures and numerous larvae of this species were obtained from the comb.

A second nest of this bee was found in a hollow tree trunk at Rio Frio, Department of Magdalena, on the 24th of September. The part of the trunk occupied by the nest was between 15 and 16 m. above the ground. Lower in the same hollow trunk were nests of *Trigona amalthea* (Oliv.) and *T. capitata* var. *zexmeniae* (Ckll.), which are described below. It was impossible to examine

this nest immediately after it was cut down, and for seventeen days the log was kept on an ant-proof base in the garden, where the bees soon made themselves perfectly at home.

When, eventually, it was opened, the cavity occupied by the colony was found to be very narrow, and the nest correspondingly constricted (Pl. XXI, fig. 3.). Its total length was about 85 cm. The opening, which was at the top of the nest, led to the outside through a small, hollow branch. The entrance passage was simply a vertical tube, 1·5 cm. in diameter and about 12 cm. long, projecting about 2 cm. above the roof of hard cerumen with which the cavity of the side branch was blocked, and continuing below it into the nest cavity as an internal spout of thin wax 5 cm. long. The upper batumen was about 5 cm. thick.

The uppermost part of the nest immediately below the upper batumen was left vacant for a length of about 7 cm. The upper mass of honey- and pollen-pots extended downwards from this point. Owing to the entrance of a large limb, the cavity in this region was wide but flat, and the pots occupied a space about 20 cm. long and 10 cm. wide, but only 4 to 5 cm. thick. In this space were twelve pollen- and six honey-pots of large size.

Comb occupied the next 22 cm. of the cavity, here about 12 cm. in diameter. Narrow and deep grooves in the wooden walls of the chamber in this part were cut off from the nest by curtains of cerumen, the involucre. At the time of examination the tiers of cells were very irregularly arranged owing to disturbances when the tree was felled and subsequent building of new cell tiers at a different angle. The old, original tiers were placed almost straight across the cavity, and in the natural position of the limb were horizontal. New cells had been constructed after the tree was cut down, and these were horizontal in the reclining position in which the log was placed in the garden.

Below the mass of comb, the cavity in the limb was very narrow and accommodated only a single row of twelve honey- and two pollen-pots, the whole mass being about 35 cm. long and 5 cm. in diameter. The honey- and pollen-pots and their contents were in every way similar to those of the first nest described.

The cells forming the comb were 12 to 13 mm. deep and 5·5 mm. across. The fresh cells, built in the new position of the nest, contained small larvae and their viscous food. They were dark brown in colour and constructed of almost pure wax, the outer walls of the tier and the tops and bottoms of the cells quite thick. In the older tiers where the larvae were full-grown and had formed their cocoons, however, the cerumen had been removed from the tops and bottoms of the cells and the edges of the tiers, leaving the light brown cocoons exposed and free of wax on their outer surfaces. This removal of the cerumen from the older tiers, it is to be remarked, may have been an unusual act arising from the cutting down of the nest and the necessity felt by the colony to replenish its worker caste quickly; that is, the cerumen may simply have been used again in the construction of the new comb.

As in the previously studied nest of this species, cells containing males, females, and workers were distributed indiscriminately throughout the comb. Only one physogastric queen was present, but two young females had recently emerged and several others, perfectly formed, were removed from cells. On a necessarily casual examination of a few pieces of new comb, no difference in the quantity of food supplied to the larvae was noted. This latter point, however, is somewhat difficult to determine, and after the disturbances to which it had been subjected and the considerable loss of its worker population, the colony

may well have been producing only workers in its new cells. The bees, as before, were very docile; and though they buzzed and swarmed about in rapid flight, they did not attack in any way while the nest was being taken. In this nest were found five species of Arthropods undoubtedly in actual association with the bees. A small mite, *Hypoaspis meliponarum*, Vitzthum, a chelifer, *Dasychernes inquilinus*, Chamberlin, and a collembolan, *Cyphoderus* sp. near *C. similis*, Folsom, were present in large numbers; and the Liodid beetles *Scotocryptus meliponae*, Girard, and *S. melitophilus*, Reitter, were represented by one and six specimens respectively.

Melipona interrupta var. *salti* was taken quite commonly throughout the year at Rio Frio, Sevilla, Aracataca, and Mamatoco, all towns or villages in the Department of Magdalena. It was collected at an estimated altitude of 500 ft. in the hills east of Rio Frio, but was not seen in the mountains. Workers were taken at Sevilla on flowers of *Mimosa pudica*, Linn., and at Mamatoco on flowers of logwood, *Haematoxylon* sp. The species seems to be a woodland form, and was usually taken in forest clearings or along wooded streams.

2. **Melipona favosa,** Fabr., var. **favosa,** Fabr.

The oven-birds of the family FURNARIIDAE construct nests of mud, some of which resemble nothing so much as a gigantic gastropod shell (Pl. XX, figs. *c* and *d*.). After due use by their builders these nests become the domiciles of various social insects, especially ants, and one which I examined was occupied by a colony of stingless bees.

This nest was found by Mr. M. A. Carriker in an acacia growing in the arid plain near Sevillano and Cienaga, Department of Magdalena. It was attached on the upper side of a horizontal branch at a height of about four metres. The original entrance to the bird's nest, an opening about 5 cm. across, was on the side, with the wall of the nest prolonged inwards so as to form a passage-way and to separate the actual nest cavity from the opening; but the original structure had been modified by the bees to suit their occupancy.

The broad opening of the bird's nest was completely closed by a thick wall of hard cerumen containing a large proportion of mud. A new opening of a diameter to suit the new tenants had been made in the roof of the structure. It was oval in outline, and 8 by 10 mm. across. This did not open directly into the nest but into a lobby (visible in Pl. XXII, fig. 2.), 2·2 cm. by 1·2 cm. in cross-section, which extended for a length of 6 cm. across the ceiling and led into the nest well at the side. The inner wall of this passage was of thick black cerumen containing much clay.

The entire inner surface of the mud nest was coated and impregnated with a black, resinous material. Thin curtains of brown cerumen (Pl. XXII, fig. 1.) surrounded the mass of comb and provided a free space between it and the walls. There were six horizontal tiers of cells (Pl. XXII, fig. 2.), each 1 cm. thick, supported above and below and between each other by pillars of cerumen. The individual cells were 10 mm. long and 5 mm. in diameter. At each end of the nest, and at the sides where there was space, were large waxen pots, spherical or oval in shape and irregular in size, some as large as 3 by 2·5 by 1·5 cm. These contained a clear, sweet, very fluid honey, or were packed with very sour pollen.

There were few adult bees in the nest and they were very docile, offering no resistance whatsoever while the nest was being dislodged. The nest contained a single queen so much swollen with eggs that the head and thorax, and especially

the wings, seemed ridiculously small. Judging from the size of its head and thorax, the young females of this species, like those of *M. interrupta*, are smaller than the workers. Males were not seen.

No melittophiles were noticed in this nest on the day it was taken, but parts of the comb were placed in a closed tin for emergence of parasites. Ten days later, when the tin was opened, it contained twenty-four adult Phorids, *Aphiochaeta scalaris*, Loew, and many larvae of the same. This is a common species of scavenger habits, and it is probable that it was not actually associated with the bees, but that eggs were laid on the comb while the nest was being examined. Further notes on this fly are given in the second part of the paper.

Melipona favosa was taken at Rio Frio at flowers of a species of *Bombax* and of *Vernonia* sp. near *patens*; at Cienaga and Santa Marta on flowers of *Tribulus cistoides*, Linn.; and near Mamatoco at flowers of logwood, *Haematoxylon* sp. It was not seen in the hills or mountains, and was nowhere a very common species. It seems to be a bushland form quite independent of tall trees and frequently met at considerable distances from heavy forest.

3. **Trigona amalthea** (Olivier).

Lightning, or the removal of a large branch, had formed a gash about 75 cm. long in the hollow trunk of an aguacate tree (*Persea gratissima*) growing in the centre of a small banana field near Rio Frio. Between 6 and 7·5 m. above the ground and immediately above the gash, the cavity of the trunk was occupied by a large colony of *Trigona amalthea* (Oliv.). Higher in the same limb were colonies of *Trigona capitata* var. *zexmeniae* (Ckll.) and *Melipona interrupta* var. *salti*, Schwarz.

The length of that part of the cavity occupied by *T. amalthea* was about 110 cm., and its diameter varied between 18 and 22 cm. The nest (Pl. XXIII, fig. 1.) could be entered only from below where, at the top of the gash in the tree, there was an oval opening about 4 cm. long and 2 cm. wide, without either external or internal entrance funnel. The base was formed by an uneven plate (the batumen) of hard cerumen containing much earth.

Upwards from the lower batumen, for 15 cm., extended a hard, brittle, coarsely cellular mass of cerumen which seemed to be an abandoned part of the nest, serving simply as a foundation and perhaps as a sort of entrance chamber. Above it, for another 15 cm., was a chaotic network of dirty cerumen rods enclosing a labyrinth of passage-ways (possibly the "spongiosa" of von Ihering, 1903, p. 242). Unless this maze aided the aeration of the nest or served as a resting chamber for the hordes of workers at night and in bad weather, I am unable to guess its use. Such a structure might originate in the abandonment of a mass of empty pollen-pots, which, collapsed and compressed and supported by their short connecting pillars of wax, would form the cerumen rods. By receiving the dirt and waste of the nest above, this network might successively be transformed into the hard, cellular mass found below it. These two regions would then represent the deserted and altered structures, especially pollen-pots, of an earlier period of the nest's history.

The next 25 cm. of the cavity was taken up by a mass of pollen-pots (Pl. XXIII, fig. 4.). Several hundreds of these were present with only a very few honey-pots, not more than ten or twelve, among them. The entire group was very compact with comparatively little open space, and formed so solid a mass that the hundreds of pots could easily be moved and handled as a unit. The individual pots were small, measuring 1·5 to 1·7 by 1·0 to 1·2 cm. They

were strongly made and supported by short, stout pillars. The cerumen forming the pots as well as their pillars was similar to that of the network below them, dark brown with blackish particles. The pollen stored varied in colour from light yellow ochre to orange, with yellow greatly predominating. It was very sour and scarcely moist enough to pack well, so that it did not mould when compressed between the fingers. The weight of the pollen in five pots varied from 0·55 to 0·73 gm., the average being 0·62 gm.

Immediately above the pollen-pots, forty centimetres of the length of the cavity was occupied by the brood portion of the nest. This was shrouded in a thin involucre (Pl. XXIII, fig. 2.) which entirely surrounded the comb and preserved a space, open except for the usual connecting rods and supporting pillars of wax, between the tiers of cells and the surface of the wood. In this part of the nest there were about thirty-five tiers of cells (Pl. XXIII, fig. 5.), 7 mm. thick and 5 mm. apart. Although horizontal, the tiers of cells in this case were not separated discs, but were connected to form a broad spiral, like a circular stairway. The entire comb, as far as it was followed, through twenty tiers, was complete in one unbroken helix. The axis was towards one side, and there was no thickened columella or hollow tube passing through the tiers. At the extreme sides of some of the tiers were small groups of honey- and pollen-pots, attached to the involucre or to the comb. The individual cells were vertical and opened upwards; 7 mm. high and 4·5 mm. in diameter. They were very numerous, and, from the fact that one of the smaller tiers contained 600 cells, I estimated that there were at least 20,000 cells in the nest. The cerumen of which the cells were constructed was lighter brown in colour and seemed to have a larger proportion of wax than that forming the pollen- and honey-pots.

The cells containing eggs or very young larvae were about two-thirds filled with a very fluid food, apparently a suspension of pollen in honey. The eggs were not attached to the cell wall but were floating on the liquid, as also were the young larvae. All larvae except those about to pupate were marked with an orange-coloured median longitudinal line, which dissection showed to be the alimentary tract packed with pollen and partially visible through the integument. It seemed that the honey from the larval food was used by the growing larva, but the pollen was strained out and stored for a time in the intestine. As this packed mass of pollen was found in the intestine of larvae which had completed their ration and were presumably full grown but was lacking in old larvae about to pupate, and as faecal pellets were absolutely and invariably absent from cells containing either full-grown larvae or pupae, it may be that the pollen is digested in the "resting" period of the larval life. One cell containing the liquid larval food was observed to be shared by two larvae, but whether both were of the *Trigona* or one a parasite or inquiline was not determined.

At the edge of the tiers of brood cells, in the middle of the nest and usually attached to the comb but in one or two cases to the involucre or its supports, were found in all twenty-six cerumen pots, only very little smaller than the pollen- and honey-pots which they much resembled. These were the cells of the young females. Two contained adult female bees, two pupae, and the remainder full-grown larvae. The walls of these queen-cells were parchment-like, being formed of a complete covering of silk which was quite thick and made a substantial cell quite independent of the cerumen which more or less covered its outer surface. One of these cells placed in hot water was cleansed of the wax and appeared as a spherical, brown, nut-like body, 14 by 8 mm. in size. No traces of food could be found in any of these cells, the larvae having

all completed their meals; but between two distinct layers of the silken cocoon at one end there were small yellow particles, certainly the voided excrement. The silken covering, then, is spun by the larva before the excrement is voided, and then a second, inner layer is spun at one end to exclude the faecal pellets from the cell chamber. These pellets, it must be repeated, were not found in cells containing either full-grown larvae or pupae of worker bees. Males of this species were not obtained; and whether they are reared in cells similar to those of the workers or in larger structures like those of the females, was not determined.

Above the comb, the remaining 15 cm. of the cavity was filled with honey-pots (Pl. XXIII, fig. 3.), with very few pollen-pots among them and these only at the sides. The honey was clear, somewhat sharp on the tongue as though fermented, and varied from colourless to a light amber tint. The nest cavity was limited above by the upper batumen.

The bees in this nest were exceedingly numerous and very bold. If one but disturbed the lower branches of the tree or merely attracted the attention of the bees from the ground a few would settle on him, buzzing fiercely, biting sharply, and becoming thoroughly entangled in his hair, for they were always sticky. Three times I climbed up the tree to locate the nest opening, and each time was fiercely attacked. Long before the nest opening was approached, and while I was still clambering on the first limb, the bees attacked in numbers. They flew about me in hundreds with a buzzing audible many metres away, settled on my clothes, and entered every opening, so that I soon had numerous bees inside my clothes biting me. They seemed deliberately to crawl to the base of the hair and bite sharply on the skin. Their bite is a distinct little pinch, and, while the effect is not lasting, to have fifty or more of these little black imps settled on various parts of one's body, all biting at the same time, is somewhat annoying and rather painful. The bees emit a distinct rancid-butter odour, as Wheeler (1913) says. They did not, however, as his, leave me when I retired to a distance, but clung in the folds of my clothes and bit at intervals until I had picked off each one individually. The nest was finally taken by a surprise attack at dawn. A rough ladder having been prepared and set in place one afternoon, my friend, Mr. Svenningsen, and myself arrived at the place just before dawn the next morning and succeeded in closing the entrance with clay, cloth, and a strip of tin. Even this was not entirely successful, and before one could work steadily at cutting down the tree a large smudge fire had to be built and hosts of the bees done to a smoky death.

The melittophiles found in this nest included five species of mites, *Celaenosthanus trigonophilus*, Vitzthum, *Trigonholaspis salti*, Vitzthum, *T. columbiana*, Vitzthum, *T. trigonarum*, Vitzthum, and *T. amaltheae*, Vitzthum, and two species of Phorid flies *Pseudohypocera nigrofascipes*, Borg., and *Melittophora salti*, Brues.

Several other nests of this species were seen but not examined. All were situated in hollow trees at a considerable height.

Trigona amalthea is easily the commonest meliponine throughout the Santa Marta region where it is known as the "mapaitero." It is ubiquitous in the lowlands, but was not taken in the Sierra Nevada. It frequently visits flowers of the banana, *Musa sapientum*, of *Antigonon leptopus*, and of several species of *Hibiscus*, and was taken at Rio Frio at the blossoms of a species of *Bombax*. At Cienaga in February large numbers were found to be attracted by the honey-dew of Membracid nymphs.

This bee has earned an unenviable reputation in the banana plantations of

Colombia on account of its habit of scarring the young fruit. Its mandibles are unfitted to make a breach in the flat surface of the banana skin, and its attack is, therefore, confined to the longitudinal ridges of young bananas before they have attained their plump maturity. From the triangular scars they form oozes slowly the sticky, milky sap of the green banana fruit, and this is apparently collected by the bees to mix with wax and resins in the formation of their structural cerumen.

4. **Trigona capitata,** Smith, var. **zexmeniae** (Cockerell).

In the same hollow limb as the nest of *Trigona amalthea* described above and the second nest of *Melipona interrupta salti* and between these two, was a nest of *Trigona capitata* var. *zexmeniae* (Ckll.). It lay between 8 and 8·6 m. from the ground, with the nest opening about the middle at a height of 8·3 m.

The upper and lower batumens of the nest were of hard and brittle cerumen containing much earth. These separated the nesting chamber from the cavity above and below. Above the upper batumen, the hollow trunk was partly filled with soil and the roots of an epiphytic plant; below the lower batumen it was empty.

The total length of the nest, when the log was opened longitudinally, was 58 cm., but a large piece of wood jutting 14 cm. downwards from the top considerably reduced the effective capacity. The width varied between 12 and 15 cm. The nest (Pl. XXIV, fig. 1.) was entered about the middle through a hollow branch broken off short. The outside opening was 12 by 7 mm., and led into an internal passage-way of cerumen built against the wooden wall. This was 8 cm. long and 2 cm. by 1·5 cm. in cross-section, and curved to the side and upwards to open into a considerable cavity in the comb.

Brood cells occupied the middle section of the nest, lying between 15 and 40 cm. above the base. In this length there were eighteen tiers of cells, besides a large vacant space near the middle into which the nest opening led. Honey-pots filled the basal 15 cm. of the cavity and extended up two sides of the comb to a height of 29 cm. One or two pots flanked the cell tiers at the top, and the remaining 18 cm. of length, minus that taken up by the intruding piece of wood, was packed with others (Pl. XXIV, fig. 2.).

The honey-pots were large, 3·5 or 4 cm. long and 2·5 cm. in diameter, and constructed of thin cerumen with the walls often adjacent so that it was impossible to take out one pot without opening others. The honey was clear, rather thin, and somewhat tart. Only four pollen-pots were found in the entire nest; two deep in the basal mass of honey-pots, and two among those at the top. They were indistinguishable externally from honey-pots. The two lower contained bright orange, almost vermilion, pollen; the two upper a dark gamboge or light brown pollen, dull in tone, in one pot all the same, in the other speckled with dull light yellow. The structural cerumen was clean-looking, brown in colour, and of a somewhat granular appearance.

All around the comb was a well-developed involucre, separating the cells from the wood in the middle section and from the honey-pots elsewhere. The tiers of cells were horizontal, being inclined across the cavity so as to compensate for the angle of the limb with the ground. They were separate, individual discs supported one above the other, 4 mm. apart, by cerumen pillars. The one tier counted consisted of 375 cells, and the entire nest contained about 5000. Individual cells measured 7 mm. long and 4·2 mm. in diameter, and were about two-thirds filled with the larval food. Those containing male bees were indistinguishable from those occupied by workers, and were scattered indiscriminately

in the comb in the ratio of about one male to twelve worker cells (September 27th). Only two queen cells were found, one containing a pupa, the other a larva. These also were situated with the male and worker cells in the tiers but were readily distinguishable by their larger size and rounded instead of flat ends. The faecal pellets of the larvae were easily to be found in all cells containing "resting" larvae or pupae.

The physogastric queen was found surrounded by workers close to the two honey-pots in the basal section, whither she had probably moved from the comb. Another female, not physogastric, was found moving over the brood cells. The young workers were secreting wax between the abdominal tergites. Sometimes six plates were present at once, one on each side, coming from under the second, third, and fourth segments. The wax plates were nearly half as large as the tergites.

This colony did not attack in any way when the nest was broken open; nor did individual bees bite the skin or pull at the hair as did *Trigona amalthea*. Perhaps on account of this failure to protect their ample stores of excellent honey the bees are known locally, in the Santa Marta region, by the name "mosca boba."

A section of comb was placed in a box without ventilation over night, and in the morning the bees were found standing on the cells fanning vigorously with their wings while keeping up a steady buzzing sound. This fanning produced a decided cooling effect, pleasant to feel with the hand.

The only melittophile found in this nest was the Phorid fly *Pseudohypocera nigrofascipes*. When the nest was opened, three days after the tree was cut down, larvae of this fly were found moving over parts of the comb.

Trigona capitata var. *zexmeniae* was taken at Cienaga and Rio Frio, Department of Magdalena, in February, August, and September, visiting flowers of *Tribulus cistoides*, Linn. It frequented forest clearings or open meadow-land adjacent to woods. Although not rare, it was not one of the common species.

5. **Trigona nigra,** Cresson, var. **parastigma** (Cockerell).

At about 2.30 o'clock on the afternoon of November 18th, after a light shower, I noticed a large number of Trigonas swarming about a corner of the house at a height of four or five metres. They were flying rapidly within a limited space about six feet square, passing and repassing each other, wheeling, turning sharply at the sides, and darting swiftly back. The numbers in flight at once left on the bewildered eye the appearance of a network of fine, evanescent lines, for ever changing position but remaining within a circumscribed area. The flight can scarcely be described as an aerial dance because it was in no way similar to the movement of such insects as crane-flies and midges. There was no wave motion, no levitation up and down; the flight was too rapid for that. There was simply the speedy dash of the insect from one side of the aerial course to the other, a twist, a turn or a sudden drop, and back again to the other side.

Viewed from below the bees seemed black, but when seen from the verandah above they appeared white. On examination it was found that they were indeed black below, but in the majority of cases partly white above. With a few swings of the net the following were taken:—

Abdomen white above, remainder of the body black	282
Abdomen white above except for dark apical fasciae of the segments	27
Abdomen grey above with dark apical faciae	15
Entirely black	78

There was a complete gradation of shade, of course, so that the above classes are quite arbitrary. All specimens taken were workers. At about three o'clock it began to rain, and the bees entered a small hole in the floor of the upper verandah.

Frequently in the next few months the bees of this same colony were observed in this peculiar flight near the opening of their nest. Each time the majority of the bees concerned were partly white, and all examined were workers. It is unlikely that this habit was connected with swarming, both because the bees invariably returned to their nest afterwards and because it occurred too frequently to be swarming by what proved later to be a very small colony. Nor could it be connected with mating, because all the bees engaged in it were workers. For these very reasons and also because most of the bees were callow, it seems most likely that the flight was concerned with the maturation of young workers, previous to their becoming fully-fledged foragers of the colony. Such a flight would seem to give the young workers practice in flying, to strengthen and exercise the muscles, and to familiarise them with the immediate vicinity of the nest opening.

The nest of this colony was built between the beams at a corner of the house. It was opened in April and examined, but, unfortunately, only casually. The bees were comparatively few, and though they flew about in concern, they did not attack in any way. The nest structures had a peculiar appearance, the cells not being arranged in tiers but like yellow beads strung irregularly on a network of cerumen fibres. The honey was contained in dark brown pots; it had a somewhat acid taste and seemed slightly fermented. Crawling over the nest structures were numbers of newly-hatched bees, which were entirely whitish or cream-coloured. These seemed unable to fly, but were apparently already assisting in the economy of the nest.

Trigona parastigma was taken at Rio Frio and Cartagena. At Rio Frio it commonly visited flowers of *Antigonon leptopus* growing near its nest.

This species constitutes an addition to the lists given by Ducke (1916, p. 25) and Wheeler (1923, p. 128) of American species which arrange their cells in a primitive fashion, in irregular groups instead of in tiers.

6. **Trigona fulviventris,** Guérin.

A colony of *Trigona fulviventris* was found near Vista Nieve at an altitude of about 5200 ft. in the Sierra Nevada de Santa Marta. The nest was situated in the base of a large tree. Its broad cerumen opening was at the surface of the ground, and the entrance passage, with a diameter of at least 5 cm., ran downwards through a mass of dead leaves and trash. Unfortunately the nest could not be obtained for detailed study. The bees flew about in large numbers as the entrance was examined, but were not pugnacious. The colony seemed to be very populous.

T. fulviventris was taken in the Santa Marta region only in the mountains. It was fairly common at Vista Nieve (at 5000 ft. altitude) in February visiting scars in the bark of Eucalyptus trees planted there by Mr. M. A. Carriker, the owner of that delightful mountain home. At 4000 to 4200 ft. on Cerro Patron, east of Rio Frio, specimens were taken in August and September.

7. **Trigona clavipes** (Fabr.).

A nest of *Trigona clavipes* was found in the trunk of a tree near the Hacienda de Papare, 27 km. south of Santa Marta. The nest-opening, about 1·5 m.

above the ground, was without a spout or lip, but its edges and the surface of the trunk about it to a radius of 10 cm. was smeared with sticky black gum or propolis. Numerous bees were on guard about the opening, their yellow bodies conspicuous against the black background. The bees flew off the trunk and deliberately attacked me as I approached within about two metres of the tree. Their bites were scarcely noticeable, but the bees were very sticky and became thoroughly entangled in my hair and on my skin.

This species was taken throughout the year at Rio Frio, Cienaga, Aracataca, Donjaca, at 500 ft. in the hills east of Rio Frio, and at 4000 ft. on Cerro Patron in the Sierra Nevada; all of these localities being in the Department of Magdalena, Colombia. At Rio Frio it was taken at flowers of a species of *Cordia*; and at Donjaca visiting the flowers of a large Asclepiad, probably a species of *Calopsus*. It appears to be a savanna form frequenting rather dry regions with bush or scattered low trees.

8. **Trigona testaceicornis,** Lepel., var. **tristella,** Cockerell.

A nest of this species was situated in the ceiling of a house at Rio Frio. The entrance passage was a vertical cerumen tube, about 2 cm. in diameter and fully 18 cm. long, which led the entering bees upwards and through a knot-hole in the side of the house. The nest itself was so situated among the beams that it could not be removed for examination. The bees acted in a most docile fashion while the nest-opening was examined.

This colony was twice observed engaged in the peculiar flight described above for *Trigona parastigma*. In this species, however, the bees flew about the nest-opening in a rather more compact swarm. Both flights were observed in the morning, once between 8.15 and 8.30 and once between 9.15 and 10 o'clock. Many specimens were examined and all were workers.

Trigona testaceicornis was taken frequently at Rio Frio visiting flowers of *Antigonon leptopus*, and once at Vista Nieve at an altitude of 5000 ft. in the Sierra Nevada de Santa Marta at a species of *Ipomaea*.

9. **Trigona silvestriana** (Vachal).

Taken only in the mountains at Vista Nieve (5000 ft.) and Cerro Patron (4000 ft.). The majority of the specimens seen at Vista Nieve were collecting gum from scars in the bark of Eucalyptus trees.

10. **Trigona postica,** Latreille.

Also a mountain species, taken at Vista Nieve (5000 ft.) and Cerro Patron (4000 ft.) in the Sierra Nevada de Santa Marta.

11. **Trigona cupira,** Smith.

Nine specimens were taken at Vista Nieve in February, three of them at Eucalyptus sap. A single specimen was obtained at 4000 ft. on Cerro Patron in August.

12. **Trigona cupira,** Smith, var. **rhumbleri** (Friese).

A single specimen was taken at Donjaca, 23 Km. south of Santa Marta, at sea-level. It was visiting flowers of a large Asclepiad, probably a species of *Calopsus*.

13. **Trigona jaty,** Smith.

One specimen from Vista Nieve, at 5000 ft. in February.

14. **Trigona tataira,** Smith.

Collected only once at Papare, near Cienaga, Department of Magdalena.

15. **Trigona dorsalis,** Smith (1854).

Taken at Rio Frio on January 9th, 1927.

16. **Trigona** sp. near **duckei,** Friese.

These tiny "sweat bees" were very abundant on Cerro Patron, east of Rio Frio, at 4200 ft. in September, but were not met elsewhere in the region.

PART TWO.

Arthropods associated with Meliponine Bees.

General Remarks.

The earliest record of an Arthropod associated with stingless bees appears to be that of Smith (1866), who simply stated that an ant, *Cryptocerus elongatus*, was destructive to nests of *Trigona* in Brazil. A few years later H. Müller (1873, 1874) described the attendance of Membracid nymphs by *Trigona cagafogo* in search of honey-dew. The first important contribution to the subject, however, was that of Girard (1874), who not only described the interesting melittophilous beetle, *Scotocryptus meliponae*, but also mentioned in general terms the occurrence of Isopod Crustacea, Dipterous larvae, Lepidoptera, and ants in the nests of meliponine bees, and of these bees in the nests of termites. In the next twenty-five years little advance was made apart from the description of four new species of *Scotocryptus* by Reitter, Sharp, and Matthews.

At the beginning of the century the appearance of noteworthy papers on meliponine ethology by Silvestri (1902), von Ihering (1903), and Ducke (1902) gave fresh impetus to the subject. Each of these writers referred to the association of bees and termites, and von Ihering added mites and a Staphylinid to the list. In all too short a paper Wasmann (1904) dealt with von Ihering's melittophiles, mentioning a total of eight forms of which six were Coleoptera. Unfortunately, the work of these investigators seems to have aroused but little interest, and although much attention has been paid during the last twenty-five years to the organisms occurring in the nests of ants and termites, those from nests of stingless bees have not been the subject of a single comprehensive study. Such contributions as have appeared have been merely the by-products of taxonomic work or casual observations made in the course of other ethological research.

The present paper, then, is the first attempt that has been made to deal in a general way with the Arthropod associates of meliponine bees. As such it labours under the usual difficulties: lack of data, paucity of material, and the necessity of co-ordinating many scattered and casual references. So far as it

deals with the latter it suffers also from the unsatisfactory state of meliponine taxonomy. It must be considered in every way a mere beginning.

Not all of the organisms mentioned below can be called melittophiles. Some are, others may not be; the point is not easily settled. Such scarce and inaccessible forms are difficult to study. Only fragments of their life-history are obtained at one time, and not until many observations have been made and pieced together is their mode of life completely ascertained and the true nature of their relation to the bees revealed. In theory, too, melittophily is difficult to deal with. The association varies in kind; we have parasites, predators, synechthrans, synoeketes, and numerous other groups, most of them unstable and ill-defined, based on the habits of the organisms themselves and on the attitude assumed towards them by the bees. It varies also in constancy; some organisms are temporarily melittophilous, or for one stage of their life-history, or only occasionally. With our present meagre knowledge of the organisms associated with stingless bees it would be unwise, then, to make our definition of melittophile too precise. In the following list I have included all the records that I have been able to find of Arthropods associated with meliponine bees, although in many cases the record is based on only a single capture and the actual nature of the association is quite unknown.

Isopoda.

Girard (1874*b*) mentions the occurrence of Isopod Crustacea in the nests of meliponine bees from the neighbourhood of Bahia, Brazil; where they were collected by Brunet.

Chernetidea.

CHELIFERIDAE.

Dasychernes inquilinus, Chamberlin (1929).

This large pseudoscorpion (Pl. XXV, fig. 1.), representing a new genus and species, was found in both nests of *Melipona interrupta salti* examined. It was not found in any other situation or in the nests of other bees, so that, as far as is known at present, it is specifically associated with *M. interrupta*.

There can be no doubt that the Arachnid was actually associated with the bees: (1) It was not taken elsewhere than in their nests; (2) it was present in both nests in considerable numbers; (3) adults were observed moving freely over the nest-structures; (4) oviposition chambers, containing a single adult together with a mass of eggs or a group of young, were found attached to the nest-structures, showing that the chelifer breeds within the nest cavity.

Some of the oviposition chambers were built actually on the side of the comb, and others on the inner side of the involucre. They consisted simply of a circular, finely woven sheet of glistening white silk stretched across a small hollow in the cerumen so as to form a rather flattened chamber nearly 10 mm. across but only 4 to 6 mm. deep. Each contained a single adult chelifer with a globular mass of eggs or a seething group of young.

No observations were made on the habits of this Arachnid, but it is not difficult to guess the part it plays in the life of the meliponae. The CHELIFERIDAE are all carnivorous animals, and this giant species, almost half as large as the bees with which it lives, probably preys upon feeble members of the colony. It seems unlikely that it could successfully attack an active adult bee, and it is improbable that it is able to penetrate the walls of the cells and feed upon the larvae and pupae they contain. It is more likely that the chelifer lurks in corners and crevices and seizes aged and decrepit or

diseased bees as they pass, holding them with its powerful pedipalps, as other species are known to hold flies and Pyrrhocorid bugs, until they die.

Wasmann (1900) has already recorded the presence of large numbers of an undetermined Chernetid in a nest of *Melipona mutata*, Lepel., taken by Goeldi in Pará.

Acarina.

H. von Ihering (1903, p. 203) mentions the occurrence of mites in a nest of *Melipona rufiventris*, Lepel. Unfortunately the acari are not more definitely identified, and the source of the bee nest, though presumably near São Paulo, Brazil, is not given.

Gamasidae.

Urozercon melittophilus, Silvestri.

Silvestri (1910) described this species from specimens carried on an individual of *Trigona cupira*, Smith, from Coxipò, Matto Grosso, Brazil.

Laelaptidae.

Meliponaspis debilipes, Vitzthum.

Five examples of this mite were taken by S. Alinder from a nest of *Melipona alinderi*, Alfken, in British East Africa. I am much indebted to Dr. H. Eidmann of Munich for sending them to me.

Hypoaspis meliponarum, Vitzthum.

This species appears to be specifically associated with *Melipona interrupta* var. *salti*. It was found in both nests examined of that species, both at Sevilla and at Rio Frio, Colombia. Those taken from the Sevilla nest were found moving over the nest-structures, chiefly in the region of the pollen-pots.

Trigonholaspis salti, Vitzthum,
Trigonholaspis columbiana, Vitzthum,
Trigonholaspis trigonarum, Vitzthum, and
Trigonholaspis amaltheae, Vitzthum.

These four species representing a new genus were described by Vitzthum (1929) from material collected in a nest of *Trigona amalthea* (Oliv.) at Rio Frio, Department of Magdalena, Colombia. The different species were not distinguished at the time of collection, so that the following field note probably includes observations on more than one of them. "Mites are present on the comb in large numbers, as many as five or six together on the top of a single cell. In one or two cases I have seen these mites inside closed cells. On breaking open one cell in particular I found a bee pupa, its eyes only faintly coloured, with a brown mite attached to it under the thorax apparently to the left middle leg; the mite was conspicuous as soon as the cell was opened. Mites are only rarely to be found on the pollen- and honey-pots, but on the comb are very numerous."

Antennophoridae.

Celaenosthanus trigonophilus, Vitzthum.

The above note applies also to this species which was found in the nest of *Trigona amalthea* (Oliv.) at Rio Frio, Colombia.

The six species of mites obtained from meliponine nests in Colombia and the one species received from British East Africa were submitted for study to Dr. H. Graf Vitzthum. All seven species turned out to be new, and they represent, among them, three new genera. This fact sufficiently indicates that they possess peculiar characters, but whether these fit them in any way for their existence in the nests of stingless bees I do not know. Dr. Vitzthum's paper, at the time of writing, has not been published.

Collembola.

ENTOMOBRYIDAE.

Cyphoderus dimorphus, Silvestri.

This species was described by Silvestri (1910) from specimens found in a nest of *Trigona cupira*, Smith, at Jalapa, Mexico.

Cyphoderus sp. near *similis*, Folsom.

Running over the walls of the nest of *Melipona interrupta* var. *salti* from Rio Frio, well inside the nest-cavity, were a great many individuals of a species of *Cyphoderus* closely allied to *C. similis*, Folsom. Both adult and immature forms were present in large numbers. When the nest was opened and exposed to the light the collembola retreated into narrow crevices in the cerumen-covered walls. No immediate connection with the bees was observed, but the insects were too numerous to be only accidentally present. As most of the species of *Cyphoderus* are myrmecophilous or termitophilous, it is probable that this species was acting as a scavenger in the bee nest as others do in the nests of ants and termites. The adults were able to jump at least 5 to 7 cm.

Isoptera.

In the association of meliponine bees and termites the former play the active rôle. They invade a termitarium and appropriate a part of it, usually in the centre, for their own use. This sharing of a single nest-structure provides the bees with a nesting site, but by no means supplies a ready-made domicile. The hard cellular mass of galleries in that part of the nest to be occupied has to be removed to make space for their own waxen structures. The usual meliponine architecture, therefore, is considerably modified, and in one nest studied by Silvestri the cells of the bees were scattered about in three or four more or less separate chambers within the termitarium. It would be interesting to know whether the bees progressively enlarge their holdings at the expense of the termites, and if so whether the process sometimes goes so far that they are left in undivided possession of the entire structure.

At the outset, when the bees first invade the nest, their intrusion is probably resented and perhaps challenged by the termites. In established colonies, however, it appears that there is little or no actual contact; the bees enter their nest through a cerumen tube and thus traverse the part occupied by the termites without disturbing them.

Among the following records, unfortunately, only those of Silvestri include the name of the termite host. This observer found four nests of *Trigona kohli*, Friese, and one each of *T. fuscipennis*, Friese, and *T. latitarsis*, Friese, in nests of *Eutermes rippertii* (Ramb.). The following is a list of the reported cases of stingless bees nesting in termitaria.

1. *Trigona crassipes*, Latr. Girard (1874*a*); in subterranean termitaria in Brazil.
2. *Trigona cupira*, Smith. Peckolt (1894), according to von Ihering (1903).
3. *Trigona kohli*, Friese. Silvestri (1902, 1903); four nests, all in termitaria of *Eutermes rippertii* (Ramb.) at Coxipò, Cuyabà, and Urucúm, Brazil.
4. *Trigona fuscipennis*, Friese. Silvestri (1902, 1903); nest in termitarium of *E. rippertii* at Coxipò, Brazil.
5. *Trigona latitarsis*, Friese. Silvestri (1902, 1903); nest in termitarium of *E. rippertii* at Coxipò, Brazil. Ducke (1916); nest in free termitarium in Brazil (Pará ?).
6. *Trigona dallatorreana*, Friese. Ducke (1902, 1916); nest in termitarium at Bélem, State of Pará, Brazil.
7. *Trigona helleri*, Friese. Von Ihering (1902; not mentioned 1903 !); nest in termitarium in Brazil.
8. *Trigona fulviventris* var. *nigra*, Friese. Von Ihering (1903); three nests in termitaria (a fourth in an ant's nest) in Brazil (São Paulo ?).
9. *Trigona pallida* (Latr.) [= *cupira*, Smith, = *helleri*, Friese, according to Ducke (1916)]. Ducke (1916); nests generally in hollow trees or in termitaria constructed in trees.

Orthoptera.

MANTIDAE.

Stagmatophora sp.

Bristowe (1925), speaking of a nest of *Trigona jaty*, Smith, mentions "a brown mantid nymph, *Stagmatophora* sp. . . . sitting close to the entrance gently swaying to and fro." It seems to be implied that the mantis preys upon the bees.

Hemiptera.

PHYMATIDAE.

Bristowe (1925) found a Brazilian Phymatid bug devouring a *Melipona*.

MEMBRACIDAE.

H. Müller (1873) records his brother's observations of Brazilian stingless bees attending Membracid nymphs on *Cassia multijuga*. In a later paper (1874) he gives the name of the Membracid as *Potnia* sp. probably *indicator*, Fairmaire, and describes the bee as *Trigona cagafogo*. Silvestri (1902) saw *Trigona cupira*, Sm., attending *Aethalion reticulatum*, L., on willow near the Cuyabà river, Brazil, and Cockerell (1920) records *Trigona amalthea* visiting the same species at "Bnito, Prov. Pernambuco," Brazil. Membracids feeding on Solanum in Panama were attended by *Trigona*, according to Lutz (1924); and meliponae were observed by Bristowe (1925) at Nictheroy, Brazil, tickling a species of *Aethalion* in order to obtain honey-dew. I have seen *Trigona amalthea* (Oliv.) collecting the secretion of Membracid nymphs near Cienaga, Department of Magdalena, Colombia.

CICADELLIDAE.

According to Silvestri (1902, p. 170), a species of CICADELLIDAE in Brazil is caressed by *Trigona peckolti*, Friese, for a sweet substance that it yields. This fact is not mentioned in the notes on *T. peckolti* (p. 152), whereas the

visit of *T. cupira* to the Membracid, *Aethalion reticulatum* (p. 152), is not discussed in the summary (p. 170). One wonders whether the reference to a Cicadellid is in error for a Membracid and that to *T. peckolti* a mistake for the adjacent *T. cupira*.

Coccidae.

Silvestri (1902) found a number of scale insects attached to the walls of the nest-cavity of *Trigona timida*, Silvestri, at Coxipò, Brazil. He supposed that they might yield a saccharine substance to the bees, but lacked decisive evidence. Schulz (1905) records several Coccids in close proximity to a nest of *Trigona emerina*, Friese, received from the vicinity of São Paulo, Brazil, but considers that they were only accidentally present.

Coleoptera.

H. von Ihering (1903, p. 203) mentions the occurrence of beetles in a nest of *Melipona rufiventris*, Lepel., of which the locality, though presumably near São Paulo, Brazil, is not given. If the beetles belonged to the genera *Scotocryptus* or *Belonuchus* as a later remark (*loc. cit.*, p. 262) seems to imply, either the host was incorrectly identified by von Ihering, or the record was omitted by Wasmann (1904) in his paper on von Ihering's material.

Staphylinidae.

Coproporus piceus, Er. (Pl. XXVI, fig. *a*.).

This small beetle is a well-known and widely distributed species, and is probably not a confirmed melittophile. However, three specimens were found in the nest of *Melipona interrupta* var. *salti* from Sevilla. Whether they were only accidentally present or whether the species is an occasional visitor to bee nests is not known. No observations of its habits were made.

Belonuchus mordens, Er.

This Brazilian species seems to be regularly melittophilous. Wasmann (1904) has reported it from the nests of *Melipona anthidioides*, Lepel., *M. marginata*, Lepel., and *M. nigra*, Lepel., at São Paulo, Brazil (von Ihering), and Luederwaldt (1917) from the nest of *M. anthidioides*, Lepel., at Ypiranga.

Xanthopygus cyanipennis, Sharp.

Found in the nest of *Trigona clavipes*, Fabr., in Franca, State of São Paulo, Brazil, according to Luederwaldt (1917).

Xenopygus analis, Er.

Reported by Luederwaldt (1917) from the nest of *Trigona clavipes*, Fabr., in Franca, State of São Paulo, Brazil.

Liodidae.

The genus *Scotocryptus*, Girard.

The genus *Scotocryptus*, so far as we know, is strictly melittophilous. The species included in it are remarkably fitted, in several respects, for their existence in the nests of stingless bees. All are strongly convex. The head, antennae, and legs may be folded beneath and completely hidden by the pronotum and elytra, so that the insect presents merely a smooth, hard,

hemispherical surface (Pl. XXVI, fig. *f.*) which is very difficult to grasp. This may be considered a protective position assumed in case of attack. The species are wingless and completely blind, both of which conditions may be regarded as concomitant with the existence of the beetles in nest-cavities. The larva is known of only one species (*parasitus*), and it occurs together with the adult form in the nests of stingless bees. How the beetles make their way to newly-founded nests is unknown.

Six specific names have been allotted in the genus, but one of these, *inquilinus*, Matthews, has been removed to the genus *Parabystus* by Portevin (1907). The remaining five, moreover, appear to represent only three valid species. Dr. Melville H. Hatch, who studied my material, kindly permits me to publish the following extract from his letter.

" Of the genus *Scotocryptus* there seem to be three valid species : (1) *meliponae*, Girard (*obscurus*, Sharp, (?) *goeldii*, Wasmann), known from Mexico to Brazil; (2) *melitophilus*, Reitter (*meliponae*, Wasmann, 1899, *nec* Girard), known from Colombia (your specimens) to Brazil; (3) *parasitus*, Reitter, known from Brazil. At least, a careful review of the descriptions of *obscurus* and *goeldii* reveals no differences. Portevin (1907, p. 81) agrees with me as regards *obscurus*. I am convinced that *goeldii* was described as a result of confusing *meliponae* and *melitophilus* as one species. *Parasitus* differs from the other two species by the absence of a series of punctures on the elytra.

" The larger of your specimens seem to be *meliponae*, the smaller seem to be *melitophilus*. On the basis of your material these species seem to differ as follows :—

" *meliponae :* length 4 mm.; eighth antennal segment not transverse, gradually wider from base, where it is little wider than the seventh; antennal club gradually formed, the ninth and tenth segments feebly transverse.

" *melitophilus :* length 2·4—2·8 mm.; eighth antennal segment transverse, abruptly wider than seventh, the club abruptly formed, the ninth and tenth segments strongly transverse; male with elytra and pronotum equally pubescent, the basal pro- and meta-tarsal segments evidently pubescent beneath and evidently larger than the second segment; female with pronotum much less conspicuously pubescent than the elytra, the basal pro- and meta-tarsal segments minutely pubescent beneath and much smaller than in male.

" . . . I do not believe that the sexual characters of *melitophilus* have been correctly described before. In fact, Reitter (1881, p. 88), in his original description, says, ' in mare nitida, in femina subopaca.' This makes me suspect that Reitter actually reversed the sexes, because the tarsal differences appear to me to show conclusively that the males are the more pubescent."

This synonymy is adopted in the following notes, but, for clarity, the names originally used are also given.

Scotocryptus meliponae, Girard (Pl. XXVI, fig. *e.*).

This, the type species of the genus, was described by Girard (1874) from specimens taken by Brunet in nests of *Melipona scutellaris*, Latr., from the neighbourhood of Bahia, Brazil. The specimens described by Sharp (1885) as *S. obscurus* also came from Bahia, but the description contains no mention of their habitat. *S. goeldii* occurs in the nests of *Melipona mutata*, Lepel., at Pará according to Wasmann (1904), who based his description (1899) on specimens received from E. A. Goeldi. Portevin (1907) records *S. meliponae* from Mexico, where it was collected by Diguet in the nest of *Melipona fulvipes*, Guérin.

Two specimens were obtained by the present writer; one from each of the two nests of *Melipona interrupta* var. *salti*. In one case the beetle was found among the nest-structures, in the other it was taken from a groove in the wall of the cavity.

Scotocryptus melitophilus, Reitter (Pl. XXVI, figs. *f* and *g*.).

Reitter (1881) described this species from Cayenne with the remark that it "bei der dortigen Honigbiene als Gast leben soll." According to Wasmann (1904) it was taken by von Ihering in the nest of *Melipona anthidioides*, Lepel., at São Paulo, and by E. A. Goeldi in the nest of an undetermined species of *Melipona* at Theresopolis, Rio de Janeiro.

The nest of *Melipona interrupta* var. *salti* from Rio Frio contained six individuals of this beetle, three males and three females. All of them were found in crevices in the wall of the nest, away from the comb, but they may have retreated there when the interior of the nest was exposed to the light. They were able to move fairly rapidly, and on account of their hardness and convexity were difficult to grasp, even with curved forceps. The rôle of this beetle in the nest is almost certainly that of a scavenger.

Through the kindness of Dr. Joseph Bequaert I received a number of meliponine bees collected by Herbert Lang at Kamakusa, British Guiana, 25th October, 1922. The phial containing the specimens was divided by cotton plugs into three parts. One part contained seven specimens of *Melipona fasciata* var. *lateralis* subvar. *kangarumensis* (Ckll.); another part three specimens of the same bee and a single male *Scotocryptus melitophilus*; and the third part five specimens of *Melipona fasciata* var. *paraensis* (Ducke) together with six examples, three male and three female, of *Scotocryptus melitophilus*, Reitter. I have not communicated with Mr. Lang on the subject, but I suppose that the *Scotocryptus* were obtained from nests of the bees with which they were placed.

Scotocryptus parasitus, Reitter.

Wasmann (1904) reports this beetle and its larva as common in the nests of *Melipona anthidioides*, Lepel., at São Paulo, Brazil (von Ihering); and as occurring also in the nests of *M. marginata*, Lepel., at São Paulo (von Ihering).

Parabystus inquilinus, Matthews.

Matthews (1887) described this species from Cerro Zunil, Guatemala. The specimens were collected by G. C. Champion in the nest of a species of *Melipona* in a hollow tree at an altitude of 4000 to 5000 feet. Silvestri (1910) has reported the same beetle in a nest of *Trigona cupira*, Smith, at Jalapa, Mexico.

NITIDULIDAE.

Colastus hilaris, Murray (Pl. XXVI, fig. *c*.).

A single specimen was found on the comb in the nest of *Melipona interrupta* var. *salti* from Sevilla. It may have been only accidentally present, as other members of the genus are found in decaying vegetable matter or under loose bark.

Brachypeplus auritus, Murray.

An Australian species, concerning which Lea (1910) says: "Nearly always to be found in nests of the little native bee (*Trigona carbonaria*) near Sydney."

Brachypeplus basalis, Er.

Said by Lea (1910) to be "a fairly common visitor to nests of the little native bee [*Trigona carbonaria*, Smith] near Sydney. . . . It is, however, quite a common bark insect."

Haptoncus luteolus, Er. (Pl. XXVI, fig. *b*.).

A common and widely distributed species, included here on the basis of a single specimen which was found in the debris of the comb in the first nest taken of *M. interrupta* var. *salti*. It is probably not regularly melittophilous.

CUCUJIDAE.

Nausibius clavicornis, Kugel.

Of this species Ganglbauer (1899) says: "Er lebt auch in alten Nestern südamerikanisher Bienen." Both the adult beetle and its larvae have been taken, according to Wasmann (1900*a*, 1904), in the nest of *Trigona ruficrus*, Latr., in the province of Rio Grande do Sul, Brazil, by H. von Ihering. This reference is undoubtedly a correction of Wasmann's earlier remark (1894, p. 135, footnote) on "*Nausibius parasita*, Wasm."

Silvanus trivialis, Grouv. (Pl. XXVI, fig. *d*.).

Two specimens of this common and widely distributed species were found in the debris of the nest of *Melipona interrupta* var. *salti* from Sevilla. No observations of its habits were made.

LATHRIDIIDAE.

Coninomus carinatus, Gyll.

A species of very wide distribution. A single specimen kindly sent to me by Dr. Eidmann was taken by S. Alinder in a nest of *Melipona alinderi*, Alfken, in British East Africa.

COCCINELLIDAE.

Cleidostethus meliponae, Arrow (Pl. XXV, fig. 2, *a* and *b*.).

Among the melittophiles found by the Swedish collector S. Alinder in a nest of *Melipona alinderi*, Alfken, in British East Africa, and sent to me by Dr. H. Eidmann of Munich, were three specimens of a very peculiar beetle. These have been studied by Mr. G. J. Arrow of the British Museum, and described by him (1929) as *Cleidostethus meliponae*, new genus and species, a very aberrant member of the COCCINELLIDAE.

Like *Scotocryptus*, *Cleidostethus* is remarkably fitted for its existence in the nests of stingless bees. It is significant, moreover, that the peculiarities of the two genera, the characters in which they differ from other genera of their respective families, are similar and apparently directed towards the same end. The entire form of *Cleidostethus*, like that of *Scotocryptus* but even more strikingly so, seems adapted for passive defence. The pronotum and the fused elytra of the beetle (Pl. XXV, fig. 2, *a*.) are all that are to be seen of it in a dorsal view. The margins of these parts are broad and flattened and extend beyond the body of the insect in a manner that reminds one of the CASSIDINAE. The head is small and may be retracted between the pronotum and the prosternum so that it is almost completely hidden from below (Pl. XXV, fig. 2, *b*, right.) as well as from above. The antennae are similarly hidden. The tibiae

of all the legs fold underneath their respective femora, and the latter fit perfectly into deep grooves in the body of the insect. The suture between the metasternum and the abdomen has entirely disappeared, and the only movable joint, that between the prothorax and the mesothorax, is made rigid by a remarkable interlocking device. The legs are short and the beetle is probably incapable of active movement. The whole body seems developed for rigidity and to enable the beetle to cling firmly and closely to the substratum, and in complete contact with it, while presenting only the convex pronotum and fused elytra to an aggressor. *Cleidostethus*, also, is wingless and completely blind.

The habits of the beetle can only be conjectured. It is impossible that it could penetrate the waxen cells to feed upon the larvae and pupae they contain, and unless, as Mr. F. Muir has suggested to me in conversation, it feeds upon the mites (*Meliponaspis debilipes*, Vitzthum) found in the nest or other small organisms possibly present, it must have forsaken the usual predatory habit of the COCCINELLIDAE and become a scavenger. The larva is unknown. The manner in which the beetle is transferred to new nests of the *Melipona* is a problem of interest. It is barely possible that the adult beetle, which is about one-fifth as long as its host, is able to cling to an adult bee at swarming time and be carried with the new colony as *Thorictus* is carried by ants and *Antherophagus* by bumble-bees.

Lepidoptera.

PYRALIDAE.

Girard (1874*a*) says that a small Galleriine moth lives normally in the nest of *Melipona bilineata*, Say, in Brazil. He also records the fact that several of the *Melipona*-nests kept at Bordeaux by Drory were attacked by the European *Galleria colonella*, Linn., which came from neighbouring bee-hives.

Diptera.

Girard (1874*a*) mentions " un grand Diptère " found in the nests of *Melipona* and *Trigona* kept by Drory at Bordeaux. Whether the fly came with the nests from Brazil or entered them in France is unknown. He also speaks (1874*b*) of Dipterous larvae found in *Melipona*-nests by Brunet near Bahia, Brazil, but to what family they pertained is not stated. Small flies were collected by von Ihering (1903, pp. 215, 262) from a nest of *Trigona dorsalis*, Smith, and their larvae were found in the pollen-pots. The origin of the nest is not precisely stated; presumably it was from the neighbourhood of São Paulo, Brazil. Schulz (1905) records a fly from a nest of *Trigona emerina*, Friese, from near São Paulo, Brazil. His description " ein Stück eines dunkelgrauen *Dipterons* mit gelblichen Schienenspitzen und Tarsen, von 2.5 mm. Körperlänge " suggests a Phorid, and possibly one of the species of *Pseudohypocera* dealt with below.

ASILIDAE.

Three records of Asilid flies attacking meliponine bees are given by Poulton (1907). A male *Damalina* sp. near *myops*, Fabr., was seen by C. T. Bingham in Lower Burma with a worker *Melipona apicalis*, Sm., as its prey. In Upper Burma the same observer saw a female *Damalina* sp. probably *myops*, Fabr., capture a worker *Melipona vidua*, Lepel. A male *Laxenecera albicincta*, Lw., together with its prey, a worker of a species of *Melipona* closely allied to *M. beccarii*, Grib., was collected by G. A. K. Marshall in Mashonaland. Bristowe (1925) observed a Brazilian Asilid fly devouring a *Melipona*.

PHORIDAE.

Pseudohypocera nigrofascipes, Borgmeier.

Larvae, pupae, and adults of this fly were found in the nests of *Trigona amalthea* and *T. capitata* var. *zexmeniae*, and in the first nest described (from Sevilla) of *Melipona interrupta* var. *salti*. The species has also been reported by Borgmeier (1925) from the nests of *Melipona pallida* (Latr.) subsp. *cupira* (Sm.), and of a species of *Trigona* from Bahia, Brazil (common name given as " irapuá," which, according to Silvestri (1902) and Ducke (1916), is *T. ruficrus*).

The adult fly (Pl. XXVII, fig. *a*.) is an active, long-legged insect and possibly depends for its safety within the nest on its own agility. It was observed running rapidly over and between the cell tiers of *Melipona interrupta* var. *salti* with complete impunity, the heavy, comparatively sluggish bees seeming unaware or regardless of its presence. Even the smaller, quicker *Trigona amalthea* made no effort to catch it, and one was watched passing quite unmolested through a group of fifteen or more individuals of this species between two tiers of comb. That no hostility was shown by the bees may, of course, have been due to the disorganised state of the colonies. Of the flies taken from the debris in the *amalthea*-nest, one had lost one and three both wings. These had apparently been broken off, but whether by the bees, or by accident, or by the flies' own efforts to escape from the sticky rubbish could not be determined.

Larvae were found in the nests of the three species of bees mentioned, but were only carefully studied in that of *M. interrupta* var. *salti*. In this nest, as in the others, they were obtained only from the comb and were not found among the pollen- or honey-pots. Moreover, they seemed definitely confined to that part of the comb containing pupae or fully-formed bees. Tiers of cells containing bee larvae and their food were placed apart in tins, but in these not a single Phorid larva or adult appeared. Parts of the comb containing bee pupae, on the other hand, yielded very many. In this latter part, cells were found penetrated and the pupae or bees within reduced to mere shells. Moreover, dead bees lying in the nest almost invariably had their heads severed and the contents of the body removed. That the Phorid larvae were responsible for this condition was shown by the following experiment. A freshly-killed bee was placed in a phial with five half-grown Phorid larvae. They entered through the neck, ate the body contents and left the empty exoskeleton. All five pupated and emerged successfully. Even when they were very numerous and the competition for food keen, however, the Phorid larvae refused to attack living pupae or adult bees. It seems clear, then, that the larva of *P. nigrofascipes* is a scavenger rather than a predator; but that it feeds on animal matter consisting of dead pupae and bees, and not upon honey, pollen, or the nest refuse.

The full-grown larva (Pl. XXVIII, fig. *a*.) is dirty-white in colour and cigar-shaped in outline. Specimens preserved in alcohol measure 5·7 to 6·3 mm. in length, 1·7 to 2·0 mm. in width, and 1·6 to 1·8 mm. in thickness. The much reduced pseudocephalon is bilobed and bears a pair of rather conspicuous antennal organs (Pl. XXVIII, fig. *b*.). These are composed of a large, dome-shaped,basal part surmounted by a collar-like second and an oval apical segment; the whole being about 0·035 mm. long. The basal segment encloses a chitinous ring, but there appear to be no sensorial rods such as Keilin has described in the antennal organ of *Phora bergenstammi*. Below each antennal organ is a maxillary organ, a small circular area bearing several minute sensoria. The bucco-pharyngeal armature (Pl. XXVIII, fig. *c*.) is well developed and about

0·43 mm. long. The ventral wing of the basal sclerite is much longer than the dorsal, but so lightly chitinised that its extremity is difficult to define. Anteriorly the bridge connecting the dorsal wings is produced forward in the form of a beak, which is strengthened by two stout rods arising from the basal portion. The intermediate sclerite is **V**-shaped, the two arms apparently articulating on each side with a slight prominence on the basal sclerite, the united apex pointing anteriorly and curving abruptly downwards. The paired lateral sclerites are forked posteriorly, and anteriorly bear several shallow notches and deeper slits which divide the rounded apex into eight or ten blunt, scarcely separated teeth. Each thoracic segment bears dorsally a single transverse row of stout, well-chitinised spines. In addition, on the first there is a pair of prominent lateral spiracles (Pl. XXVIII, fig. *c.*) about 0·045 mm. across and, including the felt chamber, 0·165 mm. long. The first seven abdominal segments each bear two transverse rows of spines, slightly elevated on two ridges with a shallow, transverse depression between. Laterally, at the margin of each segment, there is a group of four to eight larger spines. The eighth abdominal segment is abruptly depressed and flattened dorsally and bears the conspicuous posterior spiracles (Pl. XXVIII, fig. *d.*). These are circular in outline, about 0·17 mm. across and 0·30 mm. apart, and their felt chambers are 0·15 mm. long. The broadly rounded posterior margin of the segment bears eight large, flattened spines. Ventrally, the skin of all the abdominal segments is wrinkled and forms fleshy, rounded tubercles which serve as pseudopods.

The puparium (Pl. XXVIII, fig. *f.*) is elliptical in outline, dull dark brown in colour, 4·0 mm. long and 2·1 mm. wide. It is strongly convex dorsally and ventrally and attached to the substratum by its ventral surface. It is quite heavily chitinised so as to be hard and brittle, but transmitted light reveals the outlines of the enclosed pupa. A pair of conical, slightly bent processes, the prothoracic cornicles of the pupa, protrude laterally near the anterior margin of the second abdominal segment. They are about 0·2 mm. long, and their surface is circularly furrowed so that in profile their margins appear finely serrated. On emergence the fly breaks off a large plate consisting of the skin of the head, the three thoracic, and the first three abdominal segments dorsally, and the head and first two thoracic segments ventrally. At the temperature of the laboratory the pupal period occupied five days in almost all cases, one fly emerged in four, and a few required six days. The above descriptions and the figures are prepared from specimens preserved in alcohol.

Pseudohypocera clypeata, Malloch.

This species has been reported by Borgmeier and Schmitz (1923), and Borgmeier (1925) from the nest of a species of *Melipona* from the State of Jalisco, Mexico. As Borgmeier remarks, it would appear that the genus *Pseudohypocera*, of which these two are the only species known, is ethologically connected with bees.

Aphiochaeta scalaris, Loew.

After the nest of *Melipona favosa* described above had been examined, parts of the comb were placed in a closed tin box. Several days later numerous adults of *Aphiochaeta scalaris*, Loew, a common and widespread neotropical species, emerged in the tin and its larvae were found in numbers in the now mouldy comb. It is possible, then, that this species is not actually a melittophile, and that it was attracted to the comb after the nest was opened.

Larvae of *A. scalaris*, unfortunately, were not preserved. The puparia

are dull brown in colour and oval in outline. Those containing female flies measure 3·6 to 4·1 mm. long, 1·7 to 1·9 mm. wide, and 1·3 to 1·5 mm. thick; those enclosing males 2·5 to 2·6 mm., 1·2 to 1·3 mm., and 1·1 to 1·2 mm. in length, breadth, and thickness respectively. They are much more convex ventrally than dorsally, but while the dorsal surface is traversed by conspicuous ridges, the ventral surface is smooth and is glued to the substratum. Each dorsal ridge bears four small spines, and there is a single large spine at the lateral margin of each segment. The posterior spiracles of the larva are prominently raised and conspicuous on the puparium. The prothoracic cornicles of the pupa are very long, fully 0·53 mm. On emergence the fly splits off the head, the first two thoracic segments ventrally, and the three thoracic and first three abdominal segments dorsally. These parts do not come off in one large plate as in *Pseudohypocera nigrofascipes*, but in three parts, one consisting of the head, the first two ventral, and the three dorsal thoracic sclerites, and the other two of the halves of the first three abdominal tergites which split in the median line.

Melittophora salti, Brues (Pl. XXVII, fig. *b*.).

This interesting fly, which represented a new genus (Brues, 1928), was obtained from the nest of *Trigona amalthea* (Oliv.) under circumstances, described below, that leave no doubt of its melittophilous habit. The adult differs widely in form from the three preceding species, being a thick-set, short-legged creature, incapable, if one may judge from its appearance, of the alert activity that characterises the movements of *Pseudohypocera nigrofascipes*. As though to compensate for lack of agility, however, the species has morphological peculiarities that one is almost forced to consider defensive. In his description of the species Brues (1928) has called attention to the acute occipital margin with its concave posterior surface (Pl. XXVII, figs. *b* and *d*. In *b* the head is pulled forward and shows a gap between the head and thorax not visible in the natural position), and has mentioned that the head is closely applied to the thorax. Not only the junction of the head and thorax is hidden and protected, however, but also that between the thorax and the abdomen. Here the scutellum (Pl. XXVII, fig. *c*.) serves as a shield, and fits into a concavity in the anterior face of the first abdominal segment in such a fashion that there is formed a continuous, flat surface from head to ovipositor. The head, mesonotum, scutellum, and abdomen are all smooth and shining, and clothed only with very fine, microscopic, appressed hairs. The legs fold up underneath the body, the wings back along the dorsum. The ovipositor is heavily chitinised, directed downwards and backwards, and when exserted fully half as long as the abdomen. Observations on the conduct of the fly within the nest are unfortunately lacking, but these structural peculiarities certainly appear to be defensive.

The flies develop within the sealed cells of the bees. In one part of the comb at least 50 per cent. of the cells contained, besides a pupal bee uncoloured or with only the eyes faint brown, a small fly puparium. In other parts of the nest the puparia were found more rarely, but they were present in some cells, at least, of all the pupa-containing combs that were examined for them. In spite of careful and deliberate search fly puparia were not found in cells containing bee larvae, even if these were full-grown and alone in the cell without food or food residue. Of fifty-three cells examined in one group, thirty-seven contained bee pupae with the eyes coloured: twenty-four of these, or 64·9 per cent., also contained a fly puparium, but none was found in any of the

other sixteen cells containing larvae. Usually only one puparium was present, but in two cases there were two puparia in a single cell with the bee pupa. In three cases a fly larva instead of a puparium was found. The bee pupae whose cells were shared seemed perfectly normal and appeared to be developing properly. There was observed a direct correlation between the stage of development of the Phorid and that of the bee pupa. In cells containing bee larvae there were no Phorids; in those containing entirely uncoloured bee pupae the fly was in the larval stage or had just pupated; when the eyes of the bee pupa were coloured brown the fly pupae, easily visible through the transparent puparia, were grey; and with bee pupae that were assuming their colours and had black eyes there were puparia containing fully-developed Phorids. This correlation held true in so many cases that it would seem that there is necessarily some connection between the developments of the two inmates, bee and fly, of a single closed cell.

The three larvae that were seen were unfortunately not preserved and the description of the larval stage which follows is based upon what would normally be the puparium. In this species, however, there is no chitinisation, hardening, or discoloration whatsoever of the last larval skin to form the puparium; it remains an exceedingly thin, delicate, perfectly transparent membrane enshrouding the pupa (Pl. XXIX, fig. *f.*). It follows that a partial description of the larva is possible from the pupae that were preserved in alcohol. Segmentation appears to have been very poor, and in the material available cannot be distinguished at all. Chitinisation is reduced to a minimum in all parts; not only is the cuticle very thin and delicate, but also the small spines it bears, the anterior and posterior spiracles, and even the bucco-pharyngeal elements are small, scarcely coloured, and membranous in texture. There are no large spines on the cuticle, but instead a large part of the surface is covered with minute, transparent spicules, more or less ranged in rows. The antennal organ (Pl. XXIX, fig. *b.*) is only 0·015 mm. long and very simple in structure; a cylindrical segment with rounded tip upon a broad, hemispherical base. The bucco-pharyngeal apparatus (Pl. XXIX, fig. *a.*) is very reduced and composed of only three elements. Two of these, about 0·095 mm. long and 0·035 mm. apart are fairly well chitinised, curved, and divided posteriorly into three or four arms. The other, placed transversely in front of these, is very slightly chitinised and curves across without any articulation to the lateral pieces. With the scanty material available it is impossible to homologise these much-reduced structures definitely with the elements found in other Phorid larvae. It seems probable, however, that the darker, larger, lateral processes represent the basal or pharyngeal structures of *Phora bergenstammi*, *Pseudohypocera nigrofascipes*, etc., and that the single transverse process is the median, unpaired, intermediate sclerite of those species. The anterior spiracle (Pl. XXIX, fig. *e.*) measures 0·012 mm. across and 0·035 mm. long to the end of the felt chamber, and bears at its outer extremity two oval apertures. This organ rises in the centre of a circular area, about 0·07 mm. across, which is unwrinkled and without the minute spicules that adorn the adjacent cuticle. The area occupied by each posterior spiracle (Pl. XXIX, fig. *c.*) is about 0·12 mm. across, but all the parts are so very slightly chitinised that their shape and size are difficult to make out. The felt chamber appears to branch dichotomously (Pl. XXIX, fig. *d*; diagrammatic.) and communicates to the exterior through four circular openings.

The puparium, as has already been explained, is a transparent, membranous shroud. Most of its structures are dealt with in the above description of the

larva so that it is only necessary to mention the prothoracic cornicles. These are rather stout, conical processes, 0·11 mm. long. The fly emerges by pushing off a complete circular cap, but what segments are included in it cannot definitely be determined in the material at hand; presumably only the thoracic, for the cornicles remain behind on the empty puparium.

Since the bee pupae, in whose cells the fly puparia are found, are unhurt, it would seem that the larva of the fly cannot be parasitic upon them. The only obvious alternative is that the fly larvae appropriate a part of the food provided by the bees for their own young and live in the cells as commensals. This suggestion is rendered more valid by a consideration of the larval characters; the feeble chitinisation, the absence of large spines, and especially the simple form of the bucco-pharyngeal apparatus would be compatible with the development of the larva in a closed, restricted space with an ample supply of a highly nutritive, *liquid* food. Opposing the idea, however, is my consistent failure to find the Phorid larvae or puparia in cells containing bee larvae and their food, or even in those with full-grown larvae which had finished feeding. The feeding habits of the larva of *Melittophora salti*, then, remain in doubt, though it seems most probable that it is a commensal, sharing the food placed in the cell for the larval bee.

When it is considered that the bee larva develops in a closed waxen cell, sealed soon after the bee egg is deposited in it, another problem presents itself. When and how does the Phorid enter the cell? It is unlikely that the larva bores its own way through the cell wall, for none of the cells from which Phorids were obtained showed any sign of such injury. It is more probable that the adult fly lays her egg in the cell; but again, whether she does this before the cell is closed and runs the risk of attack by the bees, or whether she is able to push her strongly-chitinised ovipositor through the cell wall afterwards remains unknown.

Syrphidae.

Wasmann (1904) records the larva of a Dipteron, near *Volucella*, in the nest of *Melipona nigra*, Lepel., from São Paulo (von Ihering). Mention may also be made here of the close resemblance borne by certain Syrphid flies to particular species of *Trigona*. Shannon (1927, p. 17) writing of the subgenus *Ubristes* of the genus *Microdon* says: "One small group (about ten species) possesses a type of habitus which is so similar to the appearance of the stingless honey bees (*Trigona*) of the American tropics that they may easily be mistaken for them at first sight." Thus, *Microdon* (*Ubristes*) *lacteipennis*, Shannon, from the Amazon closely resembles *Trigona lacteipennis*, Friese, and *M.* (*U.*) *goettei*, Shannon, from the Amazon, Ego, and Pará is very similar to *T. goettei*, Friese. The larvae of *Microdon*, although usually associated with ants, have also been found in the nests of *Vespa* (Wheeler, 1926, p. 303). It is possible that the larvae of the *Ubristes*-group are to be looked for in the nests of stingless bees, just as those of certain species of *Volucella* are found in nests of the bumble-bees these flies so much resemble.

Hymenoptera.

Chalcididae.

Seven specimens of a small Chalcidid were found by Schulz (1905) in a nest of *Trigona emerina*, Friese, from the vicinity of São Paulo, Brazil.

FORMICIDAE.

Smith (1866) reports that the ant *Cryptocerus elongatus* is destructive to nests of the mosquito bee (*Trigona mosquito*, Smith) in Brazil. Much later, Peckolt (1894), from whom Smith received his specimens and information, explains that the *Cryptocerus* invades the nest, kills the bees, feasts upon the honey, and establishes itself in the place of the unfortunate colony.

According to Girard (1874) there were several ants among the insects found by Brunet in the nests of *Melipona* and *Trigona* at Bahia, Brazil. The entrance to the nest of the East Indian *Trigona laeviceps*, Smith, is kept covered with sticky propolis as a protection against ants and other intruders; Schulz (1905) records several ants (*Oecophylla smaragdina*, Fabr.) which had attempted to enter a nest of this species and had become glued in the entrance passage. A more permanent association of ants and meliponines has been described by von Ihering (1903, pp. 218, 261), who found a nest of *Trigona fulviventris* var. *nigra*, Friese, a species which usually nests in termitaria, entirely surrounded by the nest of a colony of *Camponotus rufipes*, Fabr. I have described above a colony of a small ant, *Wasmannia auropunctata*, Roger, nesting in close proximity to a colony of *Melipona interrupta* var. *salti* in the same hollow tree. It is probable that ants and stingless bees, both abundant and ubiquitous forms in the neotropics, very frequently come into contact, as rivals for a nesting site or for the honey-dew of Membracid nymphs if not otherwise.

SPHECIDAE.

Trachypus gomesii, Klug.

According to Bristowe (1925), "A Sphegid wasp, *Trachypus gomesii*, Klug, common in banks near Rio de Janeiro, stores its nests with *Melipona*, chiefly *M. ruficrus*, Latr."

VESPIDAE.

Drory (1873), reporting observations made by Brunet at Bahia, Brazil, speaks of a meliponine bee, "Tuiba amarella" ("Timba amarella," according to Girard, 1874*a*, = *T. postica*, Latr. or *T. dorsalis*, Smith), which is able to overcome marauding wasps armed with stings and two or three times its size. The record is vague and unsatisfactory, but a remark on the number of wasps found dead (more than thirty) and on their nest makes it probable that they were social Vespids. Von Ihering (1903, p. 265) reports an observation of Drory that the bees stretched a sticky material over the head of a wasp that had invaded their nest.

APIDAE.

The mutual relations of meliponine bees assume several forms which may be more clearly treated if separately discussed. The available data may be loosely grouped under the four headings, neighbourliness, fighting, robbing, and permanent social parasitism, and are so dealt with below.

A suitable nesting site, especially the cavity of a hollow tree, may be much larger than is required by a single colony, and may then be shared by two or more colonies of the same or different species. From this merely spatial association a simple form of social parasitism resembling what Wheeler (1923, p. 200) calls "neighbourliness" (Plesiobiosis) or even approaching his "tutelage" (Parabiosis) may sometimes arise. Von Ihering (1903, pp. 215, 236) found a colony of *Trigona dorsalis*, Smith, nesting in the same hollow

trunk as a colony of *T. molesta*, Puls., and knew of three nests of *Trigona dorsalis* in one tree. In the first part of this paper were described three colonies of stingless bees, *Trigona amalthea*, *T. capitata* var. *zexmeniae*, and *Melipona interrupta* var. *salti*, from nests within a few feet of each other in the same hollow tree, and, indeed, merely in different parts of the same continuous cavity. It is not suggested that there was any deliberate association of the colonies whatsoever, but it is probable that considerable protection was afforded the two docile species nesting above by the strong, vicious colony of *Trigona amalthea* living below. A much more interesting example, suggesting parabiosis, has been described by van Emelen (1918), who observed a colony of the small *Trigona jaty*, Smith, sharing a hive with a colony of the honey bee, *Apis mellifica*.

Fighting between different species of stingless bees or individuals of different colonies of the same species seems to be of common occurrence when several colonies are nesting in close proximity. The conflict appears almost always to arise from the attempted invasion of a nest by strange bees. It usually involves only a few workers on each side and generally ends in the repulse and often the death of the intruders. Drory (1873) speaks of a small *Trigona* fighting *Melipona* larger than itself, and Girard (1874*a*) records combats between *Melipona scutellaris* and *M. marginata*, *M. postica* or *dorsalis* and *Trigona flaveola*, *M. postica* and *T. angustula*, and between *T. angustula* and the hive bee, *Apis mellifica*. Frequent mention of fighting is made by von Ihering (1903), who especially mentions individuals of *M. rufiventris* killed by *M. anthidioides* (p. 204) and by *T. molesta* (p. 260). Fighting on a large scale, colony against colony, has been reported by Müller (1874*a*, quoted below) and by von Ihering (1903, p. 261), who describes the attack upon a nest of *T. cagafogo* by a swarm of *T. dorsalis* and the slaughter of its defenders by the victorious swarm.

Robbery and its prevention is the usual incentive for the fighting described above. Fritz Müller (1874*a*) writes that *Trigona limao* "never appears to collect honey or pollen from flowers, on which, at least, I have never seen it. It robs other species of their provisions and sometimes takes possession of their nests, killing or expelling the owners. The hives in my garden have often been invaded, and two of them destroyed, by these robbers, and I have seen in the forest several nests, formerly inhabited by other species, occupied by them." The universal desire to benefit by the toil of others is common to all the stingless bees according to von Ihering (1903), who thinks that upon occasion, and with opportunity, individuals of any species will enter the nest and steal the provisions of another colony. Certain forms, however, are especially given to such thieving, among them *M. rufiventris*, *T. ruficrus*, *T. dorsalis*, and *T. limao*. He points out, however, that even the worst of these are working bees which do not live entirely by plunder, but also collect their own honey and pollen (p. 259). On this point he definitely disagrees (p. 261) with Müller's opinion of *T. limao* quoted above. Von Ihering corroborates Müller's account of the complete invasion of the nest of one species by another, however. Swarms of *Trigona dorsalis* are said (p. 260) to prefer to take possession of a nest already occupied rather than to use a suitable uninhabited site, and mention is made of nests of *Melipona anthidioides* and *Trigona cagafogo* thus invaded and occupied by *T. dorsalis*. The cases of simple robbery first described above resemble the simple form of social parasitism which occurs among the ants, and which Wheeler (1923, p. 200) calls "brigandage" (Cleptobiosis). The complete occupation of a nest by an

invading colony, with immediate expulsion or slaughter of the rightful owners apparently does not occur among the FORMICIDAE, and the habit has no place in Wheeler's classification.

No case of permanent social parasitism, a phenomenon which occurs frequently among the ants, is definitely known to occur among the stingless bees. *Trigona* and *Melipona* have not developed a related group of social parasites bearing to them the relation that *Psithyrus* holds with *Bombus*; nor is it established that any species of meliponine bee is parasitic upon another. *Trigona limao*, Smith, was long considered a parasitic species (F. Müller, 1874, 1874*a*), a view that seemed all the more likely because its posterior tibiae lack a corbicula, but it has been shown by Silvestri (1902), von Ihering (1903), and Fiebrig (1908) to build independent nests and collect honey and pollen in the ordinary manner. According to von Ihering (1903, p. 255), H. Müller (1873) mistook the young queens of *Melipona* for parasitic forms: he saw them emerge from cells identical with those which produced workers but noticed their small size and their lack of a pollen-collecting apparatus. Although these cases were in error it is still possible that parasitic or inquilinous forms await discovery. Indeed, Wheeler (1913) has already reported a likely case. Writing of *Trigona townsendi*, Cockerell, he says: "The single specimen of this minute bee . . . was taken from a nest of *T. frontalis* at Panzul, Guatemala, together with several workers of this latter species. It is therefore, in all probability, an inquiline, which like so many inquilinous or parasitic bees and ants, resembles its host in size and coloration." With our present meagre knowledge it would be unwise to deny the possibility of there being parasitic species of stingless bees. For the present we can only await further information. If they do occur they will probably be found like *Psithyrus* and the parasitic species of *Vespa* to have lost their worker caste.

DISCUSSION.

The foregoing account of the associates of stingless bees includes reference to members of eleven orders of Arthropoda. The records that are sufficiently definite to permit a more precise classification represent twenty-six families and thirty-nine genera; while, excluding the remarks on the mutual relations of meliponine bees, there are forty-four associates specifically identified. Several of these, however, are not nest associates. Confining our attention in this discussion to the Arthropods found in the nests of stingless bees (cf. Table I) and omitting the inter-relations of the bees themselves, we have to deal with ten orders, nineteen families, thirty genera, and thirty-seven species.

This tally is so palpably incomplete that one hesitates to base a discussion upon it. More facts are needed before conclusions may safely be drawn, and the following remarks are rather to be considered in the nature of suggestions.

Nineteen families of Arthropods have representatives among the known nest associates of stingless bees. Of these..seventeen also include myrmecophiles among their number (cf. Table I), and at least thirteen have termitophilous members (probably more: I have been unable to find the information I would like on this point). From this it may be taken that in general the nest associates of stingless bees are derived from the same sources (families) as those of ants and termites.

Thirty genera and thirty-seven species of nest associates of stingless bees are to be considered in this discussion. Of the thirty genera, only three

(*Hypoaspis*, *Cyphoderus*, and *Aphiochaeta*) are also associated with ants, and only four (*Urozercon*, *Cyphoderus*, *Eutermes*, and *Camponotus*) with termites. These thirty genera, indeed, include a high proportion of quite peculiar groups, apparently specialised for their existence in nests of the MELIPONINAE and unknown from any other situation. Such are *Dasychernes*, *Meliponaspis*, *Trigonholaspis*, *Celaenosthanus*, *Scotocryptus*, *Parabystus*, *Cleidostethus*, *Pseudohypocera*, and *Melittophora*. Further, not one of the thirty-seven species under discussion is either myrmecophilous or termitophilous. It appears, then, that although the nest associates of stingless bees are derived from the same sources (families) as those of ants and termites, they have developed along entirely independent lines. They are not organisms which first lived with other social insects, ants or termites, and then enlarged their sphere to include the nests of stingless bees, but an entirely new set of forms developed in direct relation with their meliponine hosts.

This special fauna probably owes its existence to the peculiarities of the environment in which it is found. The nests of stingless bees impose upon guests and intruders a set of conditions entirely different in many ways from those that obtain in ants' nests and termitaria. Some of these conditions are so peculiar and yet so rigorous as to influence profoundly the form and habits of the organisms that would dwell among them.

First, the nests of stingless bees are comparatively simple cavities, completely enclosed except for the single, usually guarded or protected, opening, even the subterranean nests being encased in a stout cerumen envelope. The entrance of intruders, therefore, is feasible at only one point, and that a point of danger. This condition renders it impossible for nest associates to pass in and out at will, as they often may through the earthen walls or several openings of many formicaria and termitaria. Once in the nest they must be prepared to remain. Accordingly, we find that many of those whose habits have already been in part discovered are known to breed within the nest-cavity (*Dasychernes*, probably the mites, *Cyphoderus*, *Scotocryptus*, *Pseudohypocera*, and *Melittophora*). It may well be that others (almost certainly the mites, perhaps *Cleidostethus*) cling to the bees themselves and are thus able to pass the portal in safety.

Secondly, the nest-cavities of stingless bees contain only the waxen structures erected in them by the bees themselves; the litter inevitable in a series of unlined galleries and chambers excavated in soil or wood is practically non-existent. Hiding-places within the nest, therefore, are relatively few, and the number of associates is probably much more strictly limited than in the nests of ants and termites. Moreover, as will be pointed out later, intruders depending for their safety in the nest on their resemblance to the environment must conform to the colour or texture of cerumen, the only substance normally exposed.

Thirdly, the use of wax for brood and storage cells envelops the immature stages and the stored provisions in a complete and relatively impenetrable covering. An ordinary predator or thief would be unaware of prey or booty so hidden, and, if aware, could not get at it. Special adaptations, both psychological and morphological, therefore, are required if the young bees or the stored food are to be obtained.

Fourthly, the highly specialised diet of the bees, restricted as it is to honey and pollen, imposes a very special taste and digestion on such intruders as would share their stores of food. This condition has another effect which will be discussed later, it practically precludes the existence of such symphiles

TABLE I.

Conspectus of the Arthropods associated with Meliponine Bees.

Order.	Family.	Genus.	Species.	Nest Associate.	Myrmecophilous.*	Termitophilous.*
Isopoda				×	1, 2	3
Chernetidea				×	1, 2	3
	Cheliferidae			×	1, 2	
		Dasychernes		×	—	—
			inquilinus	×	—	—
Acarina				×	1, 2	1, 3
	Gamasidae			×	1, 2	3, 5
		Urozercon		×		3, 5
			melittophilus	×	—	—
	Laelaptidae			×	1, 2	3, 5
		Meliponaspis		×	—	—
			debilipes	×	—	—
		Hypoaspis		×	2	
			meliponarum	×	—	—
		Trigonholaspis		×	—	—
			salti	×	—	—
			columbiana	×	—	—
			trigonarum	×	—	—
			amaltheae	×	—	—
	Antennophoridae			×	1, 2	6
		Celaenosthanus		×	—	—
			trigonophilus	×	—	—
Collembola				×	1, 2	1, 3
	Entomobryidae			×	1, 2	3
		Cyphoderus		×	1, 2	3
			dimorphus	×		
			near *similis*	×		
Isoptera				×	1, 6	3
	Termitidae			×	1, 6	3
		Eutermes		×		3
			rippertii	×		
Orthoptera					1, 2	1
	Mantidae					
		Stagmatophora				
Hemiptera				×	1	1, 3
	Phymatidae					
	Membracidae				1, 2	
		Potnia				
			near *indicator*			
		Aethalion				
			reticulatum			
	Cicadellidae (?)					1
	Coccidae			×	1, 2	1
Coleoptera				×	1, 2	1, 3
	Staphylinidae			×	1, 2	1, 3
		Coproporus		×		
			piceus	×		
		Belonuchus		×		
			mordens	×	—	—
		Xanthopygus		×		
			cyanipennis	×		
		Xenopygus		×		
			analis	×		
	Liodidae			×		
		Scotocryptus		×	—	—
			meliponae	×	—	—
			melitophilus	×	—	—
			parasitus	×	—	—

* The numbers in these columns denote affirmation and refer to authorities, as follows: 1—Wasmann, 1894; 2—Donisthorpe, 1927; 3—Silvestri, 1918–20; 4—von Ihering, 1903; 5—Hegh, 1922; 6—Silvestri, 1903. A dash indicates that the genus or species is known only from the nests of stingless bees.

TABLE I.—*continued.*

Order.	Family.	Genus.	Species.	Nest Associate.	Myrmecophilous.*	Termitophilous.*
		Parabystus		×	—	—
			inquilinus	×	—	—
	Nitidulidae			×	1	5
		Colastus		×		
			hilaris	×		
		Brachypeplus		×		
			auritus	×		
			basalis	×		
		Haptoncus		×		
			luteolus	×		
	Cucujidae			×	1	
		Nausibius		×		
			clavicornis	×		
		Silvanus		×		
			trivialis	×		
	Lathridiidae			×	1	1, 3
		Coninomus		×		
			carinatus	×		
	Coccinellidae			×	1, 2	
		Cleidostethus		×	—	—
			meliponae	×	—	—
Lepidoptera				×	1, 2	1, 3
	Pyralidae			×		
		Galleria		×		
			colonella	×		
Diptera				×	1, 2	1, 3
	Asilidae					
		Damalina				
			near *myops*			
		Laxenecera				
			albicincta			
	Phoridae			×	1, 2	3
		Pseudohypocera		×	—	—
			nigrofascipes	×	—	—
			clypeata	×	—	—
		Aphiochaeta		×	2	
			scalaris	×		
		Melittophora		×	—	—
			salti	×	—	—
	Syrphidae			×	1, 2	1
		Volucella vic.		×		
		Microdon			1, 2	1
			lacteipennis			
			goettei			
Hymenoptera				×	1	1, 5
	Chalcididae			×	1	
	Formicidae			×	1	1, 6
		Cryptocerus		×		
			elongatus	×		
		Oecophylla		×		
			smaragdina	×		
		Camponotus		×		1, 5
			rufipes	×		
	Sphecidae				1	
		Trachypus				
			gomesii			
	Vespidae (?)					
	Apidae			×	4	4, 6
		Melipona	spp.	×		
		Trigona	spp.	×	4	4, 6
		Apis		×		
			mellifica	×		

as the trichome-bearing Lomechusini, CLAVIGERIDAE, PAUSSIDAE, and HISTERIDAE so welcome in ant communities.

Fifthly, this same restricted diet of the bees, pollen and honey, is highly nutritious. It affords no by-products or waste parts, and is almost completely assimilable so that there is little or no waste or refuse to attract ordinary scavengers.

Finally, several minor considerations may have assisted to produce the peculiar fauna of stingless-bee nests. Their predominantly arboreal situation may have played a part,—it would be interesting in this connection to compare the nest-associates of subterranean and arboreal species, but at present this is impossible. The ability of all the working members of the colony to fly must also influence the accessibility of the nest; and the lipped or sticky entrance-funnels of some species probably prevent the ingress of many would-be associates.

Myrmecophiles and termitophiles have been classified according to their habits and their mode of life within the nests of their hosts into four principal groups: (1) the synechthrans, or inimically persecuted intruders; (2) the synoeketes, or indifferently tolerated guests; (3) the symphiles, or true guests; and (4) the ecto- and endo-parasites. Our knowledge of the habits of the nest-associates of stingless bees is too meagre to permit their present arrangement even in these major divisions, but the places of a few of them may be suggested. The ecto- and endo-parasitic habit is probably represented by some of the mites and the Chalcidids respectively. *Dasychernes* may well be a synechthran. The synoeketes are exemplified almost certainly by *Cyphoderus* and perhaps by some of the species of Acarina. The great majority of the known associates cannot be classified. It is probable, however, that with the possible exception of certain Homoptera there are no true symphiles among the associates of stingless bees. The reason for this has already been suggested. Meliponine bees, like other members of their large family, have a very restricted diet and highly specialised mouth-parts to enable them to collect and use their food. Droplets of a saccharine fluid such as are yielded by many Homoptera and the larvae of some Lepidoptera may be used by them, indeed, we have several records of stingless bees attending Membracid nymphs for their sweet secretion, but it is improbable that the minute quantities of material to be sucked from the trichomes of such insects as the coleopterous symphiles of ants is either attractive or accessible to the meliponine bees. Synechthrans, synoeketes, ecto- and endo-parasites, and trophobiontes such as Coccids and Membracids will be found associated with stingless bees, but symphiles, or true guests, will probably be few or wanting.

It has already been pointed out that hiding-places within the nests of stingless bees are relatively few. Intruders, therefore, cannot so easily escape the notice of their hosts, or, if pursued, so readily take refuge in a mass of debris as those in nests of ants and termites. The nest-associates of whose habits we have any knowledge seem to escape the resentment of the bees in one of the following ways. (1) They may be so small as to escape notice altogether (Acarina? *Cyphoderus*?). (2) They may be either small enough or flat enough to retreat into minute cracks or spaces where they cannot be followed (the Acarina, *Cyphoderus*, the Staphylinids, Nitidulids, and Cucujids, *Coninomus*, and *Dasychernes*, which, although large, is very flat and can go into very narrow crevices). (3) They may be so agile as to be able to escape their hosts (adults of *Pseudohypocera*?). (4) They may be able temporarily to repel the bees (*Dasychernes*?). (5) They may be of such a form and have such a hard,

smooth, and rounded surface that they cannot be grasped. This seems to be a favourite method among the coleopterous associates and is well exemplified by *Scotocryptus*, *Parabystus*, *Cleidostethus*, and possibly, in another form, by *Coproporus*.

Another method by which intruders might escape harm within the nests of social insects, by applying the principle of mimicry, requires separate treatment. I have already mentioned the close similarity of certain Syrphid flies of the subgenus *Ubristes* and species of *Trigona*, but this case of purely visual resemblance seen, as far as we know, only outside the nest and apparent, perhaps, only to entomologists, need not be considered here. Restricting our attention to the possibility of effective mimicry within the nest, it is obvious, first of all, that an organism which sufficiently resembled either the nest structures or the rightful inhabitants of a nest might be able to live unchallenged within it. It is apparent, also, that in the dark interior it would not be so essential to look like a part of the nest or one of the colony as to feel like or smell like one. In the nests of ants and termites it is supposed that many insects are thus able to escape notice. The possibility of the effective operation of mimicry in the nests of stingless bees, however, is much reduced. As has already been pointed out, these nests are usually simple cavities containing only such structures as are placed there by the bees themselves. An organism depending for its safety on its resemblance to the environment would have to resemble the texture and odour of cerumen; nothing else would serve. This condition is not prohibitive,—we may already have an example in *Cleidostethus meliponae*, whose size and texture and ability to cling very closely to the substratum may allow it to pass as part of the nest structure,—but it does very rigorously restrict the form of those inquilines that may depend upon it. Passing on from this protective resemblance to the environment to true mimicry, we find a further restriction that may, indeed, almost prohibit the application of this principle in the nests of stingless bees. The egg, larval, and pupal stages of the MELIPONINAE being passed in a sealed cerumen cell, mimicry of the adult bee is the only resemblance that could be of any value to a nest-associate. Assuming that the appropriate odours might readily be obtained from the nest itself, the very specialised shape, pubescence, and sculpture of the adult bee would not be easily acquired or simulated. None of the known nest-associates could conceivably pass in form or texture for a stingless bee. To step deliberately into the realm of mere conjecture, is it possible that the Syrphid *Ubristes* does so, that it enters a nest to lay, and that its larva develops therein?

This discussion commenced with a point of similarity between myrmecophiles and termitophiles on the one hand and meliponophiles on the other. It may close with a second. The several orders of Arthropods contribute to the fauna associated with ants, termites, and stingless bees in about the same proportion (Table II; including all associates, not only inquilines). The Coleoptera provide most of the associates in each case and are followed by the other orders in approximately the same relation. It would, of course, be desirable here to compare the associates of the social bees as a whole with those of ants and termites; and also to compare the associates of the meliponine bees with those of *Bombus* and *Apis*. Unfortunately, however, the latter groups have never been thoroughly studied from this point of view, the data are still wanting, and the comparisons, which would be full of interest, cannot yet be made.

The preliminary nature of this paper has already been stressed. How completely unexploited the subject is may be gathered from the fact that of

TABLE II.

Comparison of the Sources of the Associates of Meliponine Bees, Ants, and Termites.

Order, etc.	Associates of Meliponine Bees.	Myrmecophiles (after Wasmann, 1894).	Termitophiles (after Warren, 1919).
Insecta . . .	42	1177	466
Coleoptera . .	16	993	348
Hymenoptera . .	9	39	31
Diptera . . .	7	18	22
Hemiptera . .	5	72	10
Collembola . .	2	20	38
Isoptera . . .	1	0	8
Orthoptera . .	1	7	5
Lepidoptera . .	1	26	3
Embioptera . .	0	1	1
Arachnida . . .	9	60	16
Myriapoda . . .	0	?	9
Crustacea . . .	1	9	5
Total . . .	52	1246	496

the thirty-seven specific records of nest-associates given above seventeen are entirely original. Any careful examination of a meliponine nest is likely to add to the account, and an extended observation of the habits of the organisms concerned would greatly modify it. A splendid opportunity lies before the entomologist fortunately situated in the tropics. If he is attracted to the discovery of new forms, few faunas will yield a higher proportion of new species than that specialised for its existence in the nests of stingless bees; if to study the ways of things delight him more, there he will find many things whose ways are quite unknown.

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Explanation of Plates XX–XXIV.

Plate XX.

Nesting-places of Colombian stingless bees.

a, Hollow tree-trunk with entrance to nest of *Melipona interrupta* var. *salti*, Schwarz, at the bottom of the gash; *b*, vertical section of same, showing the nest-structures (diagrammatic); *c*, nest of Oven-bird (*Furnarius leucopus exilis*, Todd) occupied by a colony of *Melipona favosa*, Fabr.; *d*, horizontal section of same (diagrammatic).

Plate XXI.

Nests of *Melipona interrupta* var. *salti*, Schwarz.

Fig. 1. Upper part of nest from Sevilla, showing the comb.
2. Lower part of nest from Sevilla, showing pollen-pots.
3. Nest from Rio Frio.

Plate XXII.

Nest of *Melipona favosa* var. *favosa*, Fabr., in the deserted nest of an Oven-bird.

Fig. 1. Clay wall removed to show comb, pollen-pots, and involucre.
2. Section of nest showing the entrance-passage, provision pots, and brood-cells containing larvae and pupae.

Plate XXIII.

Nest of *Trigona amalthea* (Oliv.).

Fig. 1. Complete nest with the involucre removed.
2. Part of nest, showing the involucre in place about the comb and a mass of pollen-pots below.
3. Group of honey-pots.
4. Group of pollen-pots.
5. Several tiers of comb with provision pots at the side.

Plate XXIV.

Nest of *Trigona capitata* var. *zexmeniae* (Ckll.).

Fig. 1. General view of nest.
2. Upper part of nest, showing upper batumen, honey-pots, comb, and fragments of the involucre.

Explanation of Plates XXV–XXIX.

Plate XXV.

Arthropods from nests of stingless bees.

Fig. 1. *Dasychernes inquilinus*, Chamberlin, from a nest of *Melipona interrupta* var. *salti*, Schwarz, in Colombia.

2. *Cleidostethus meliponae*, Arrow, from a nest of *Melipona alinderi*, Alfken, in British East Africa. *a*, Dorsal view; *b*, ventral view with the head and appendages extended on the left, retracted on the right.

Plate XXVI.

Coleoptera from nests of *Melipona interrupta* var. *salti*, Schwarz, in Colombia.

a, *Coproporus piceus*, Er. (Staphylinidae); *b*, *Haptoncus luteolus*, Er. (Nitidulidae); *c*, *Colastus hilaris*, Murr. (Nitidulidae); *d*, *Silvanus trivialis*, Grouv. (Cucujidae); *e*, *Scotocryptus meliponae*, Girard (Liodidae); *f* and *g*, *Scotocryptus melitophilus*, Reitter (Liodidae). (All figures drawn to same scale.)

Plate XXVII.

Phorid flies from a nest of *Trigona amalthea* (Oliv.) in Colombia.

a, *Pseudohypocera nigrofascipes*, Borg.; *b*, *Melittophora salti*, Brues; *c*, junction of thorax and abdomen of *M. salti*, largely covered by the scutellum; *d*, head and part of thorax of *M. salti* from the side.

Plate XXVIII.

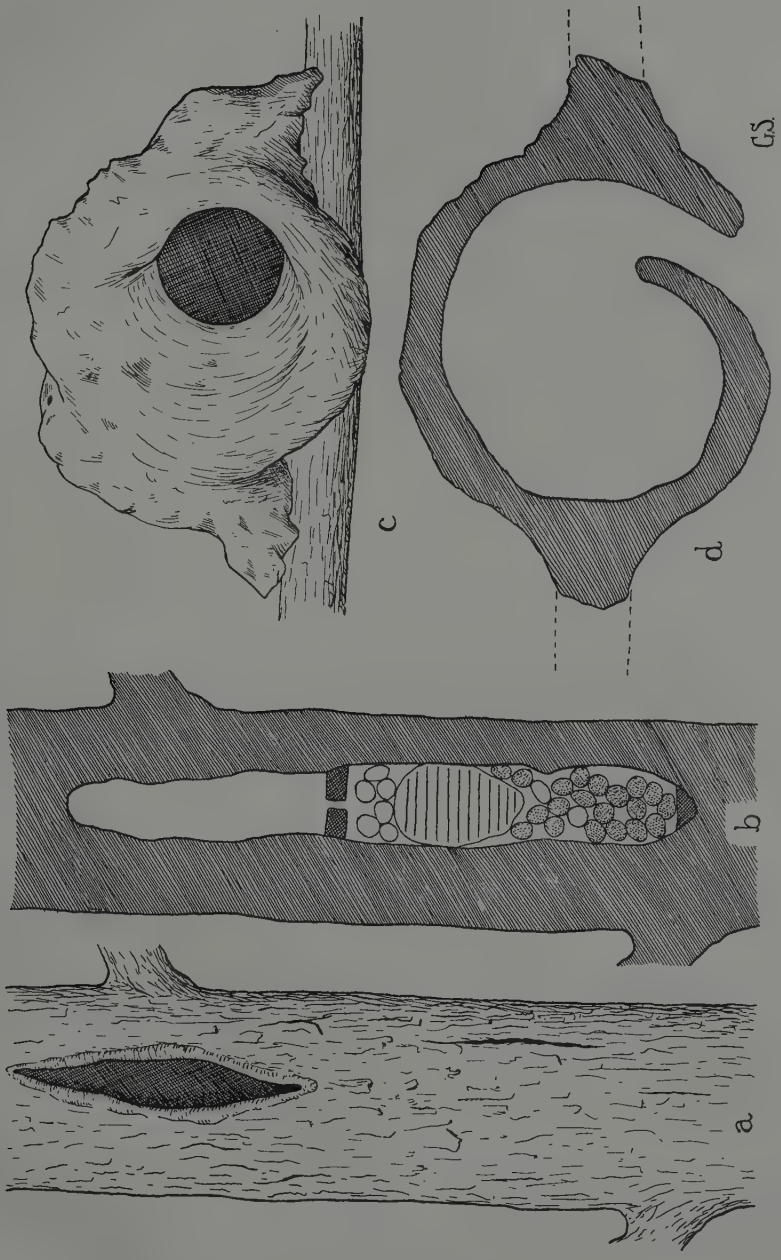
Larva and puparium of *Pseudohypocera nigrofascipes*, Borg.

a, Full-grown larva; *b*, antennal organ; *c*, anterior spiracle; *d*, posterior spiracle; *e*, bucco-pharyngeal apparatus; *f*, puparium.

Plate XXIX.

Larva and pupa of *Melittophora salti*, Brues.

a, Bucco-pharyngeal apparatus; *b*, antennal organ; *c*, posterior spiracle; *d*, structure of posterior spiracle (diagrammatic); *e*, anterior spiracle; *f*, pupa enclosed in the transparent puparium.



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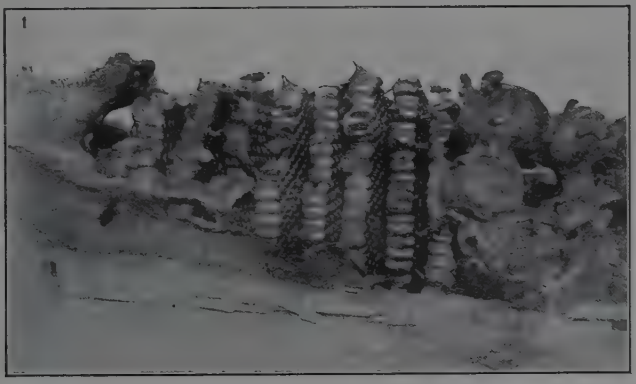
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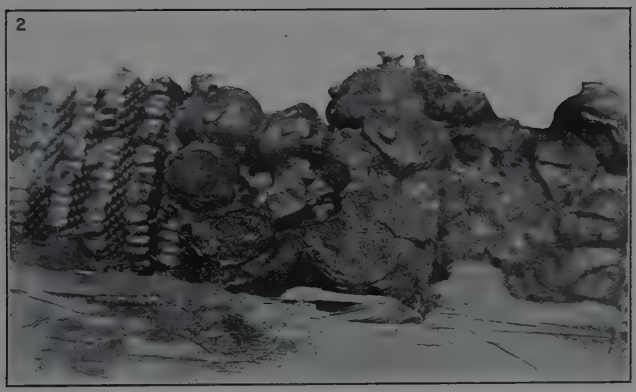
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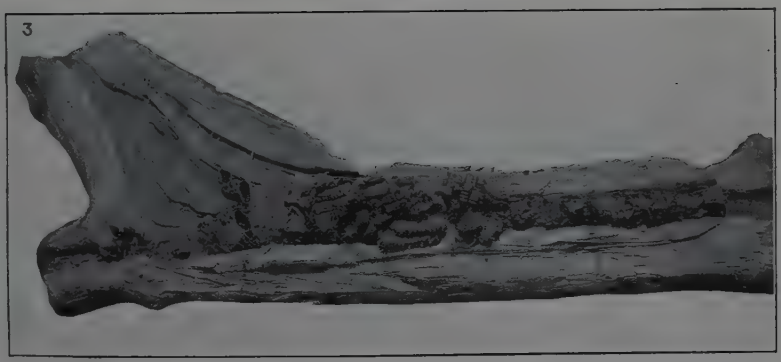
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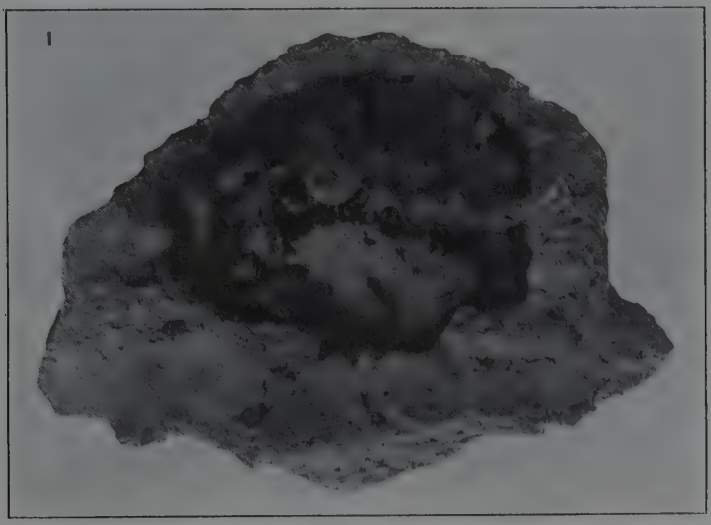
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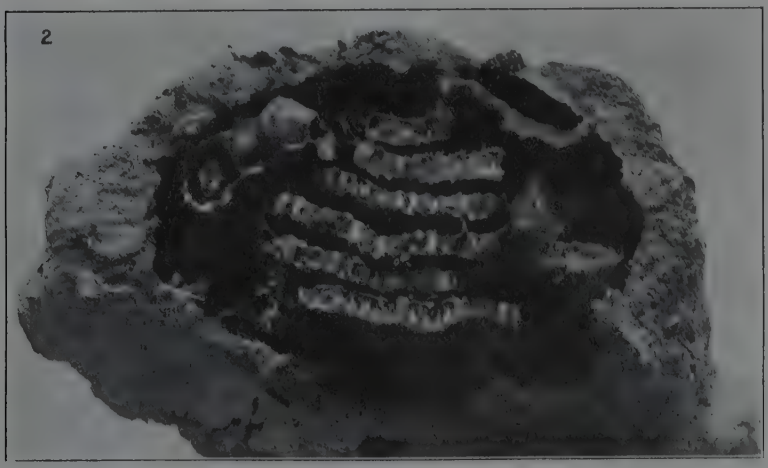
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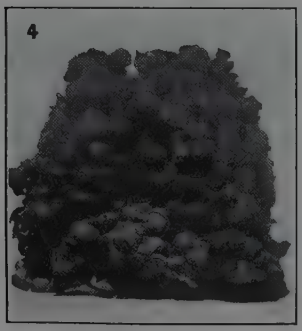
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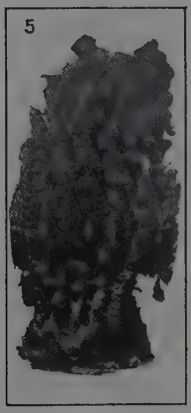
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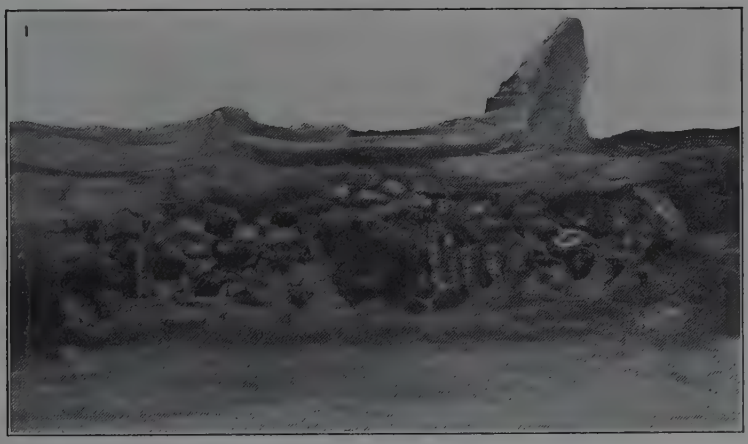
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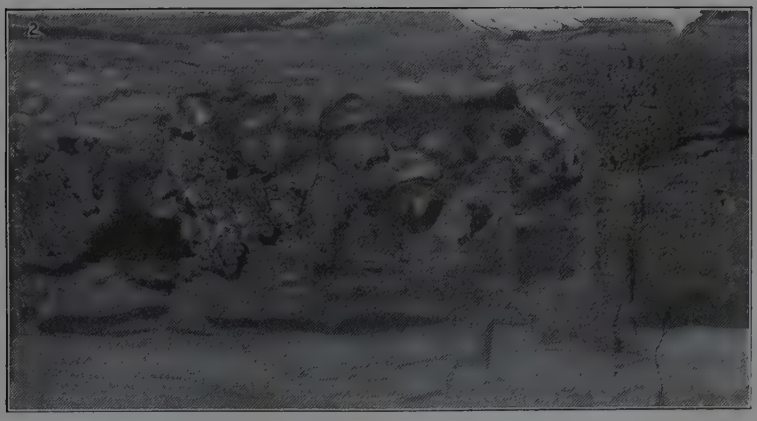
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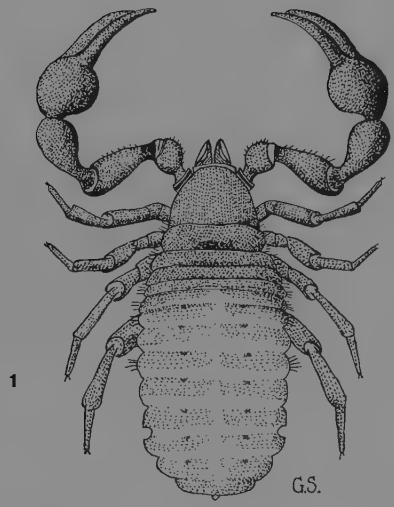
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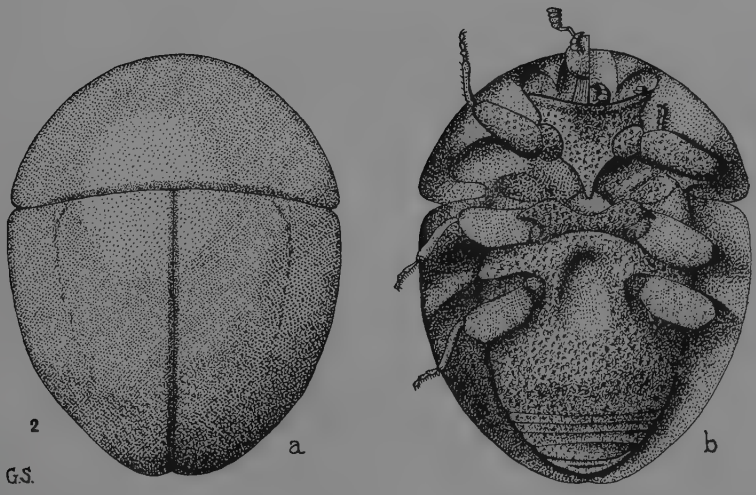
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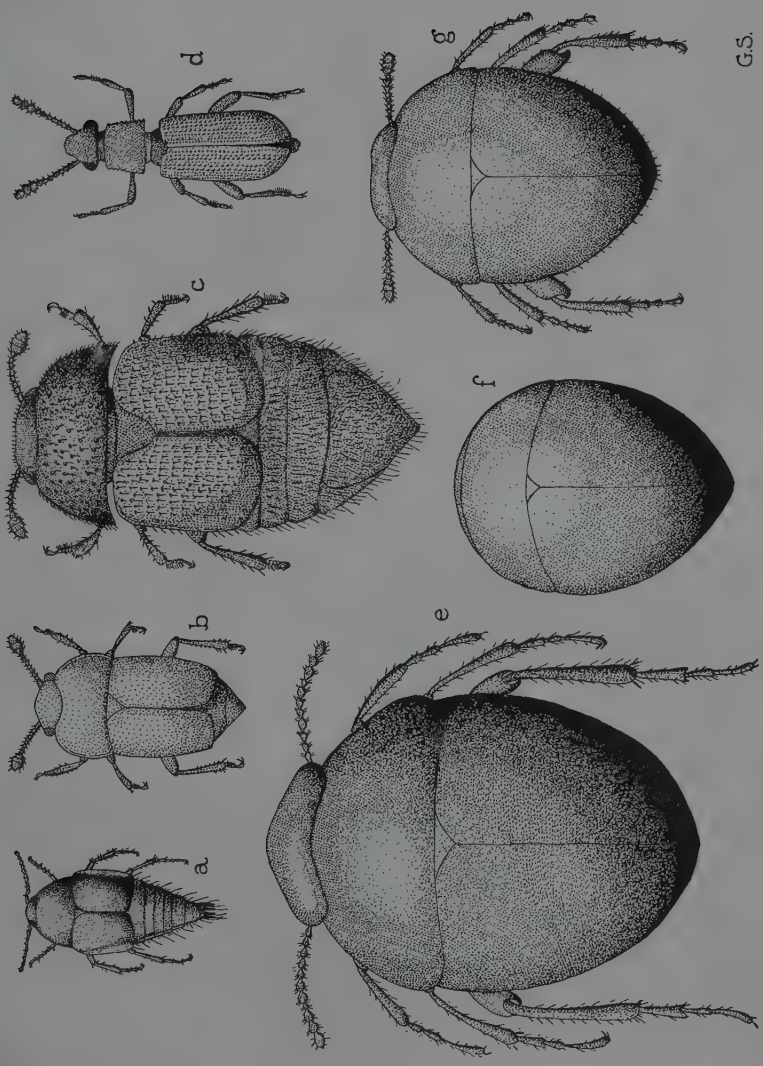

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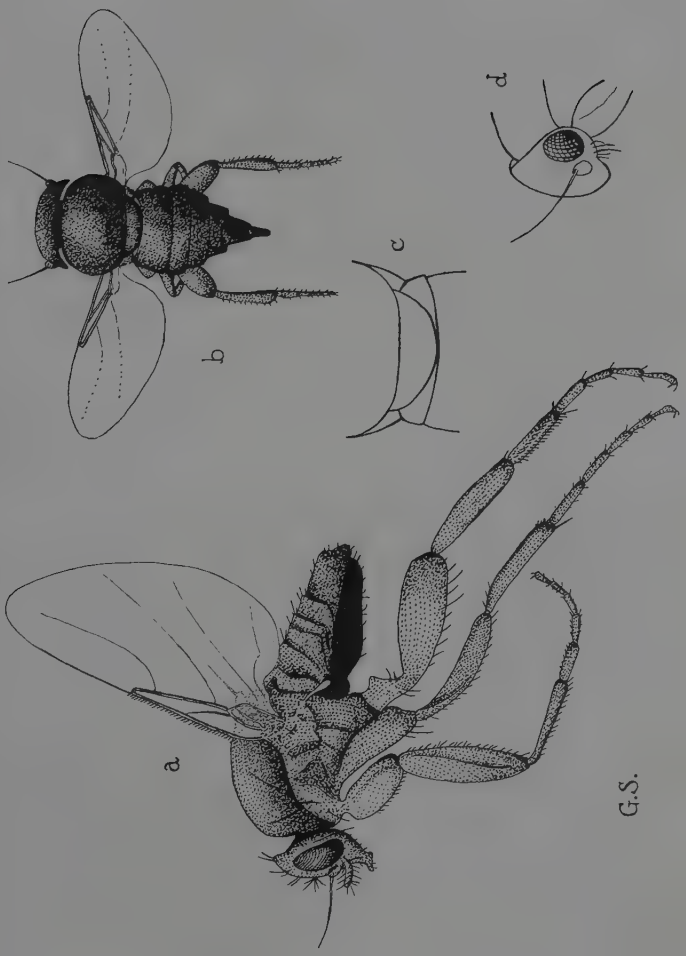

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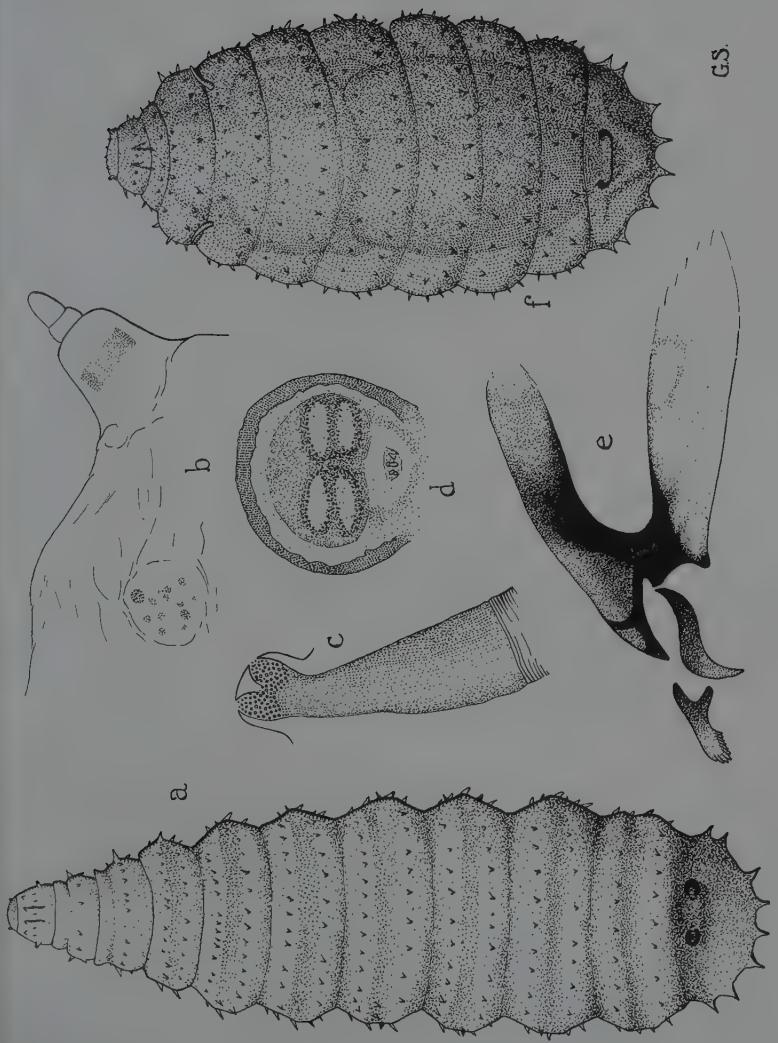

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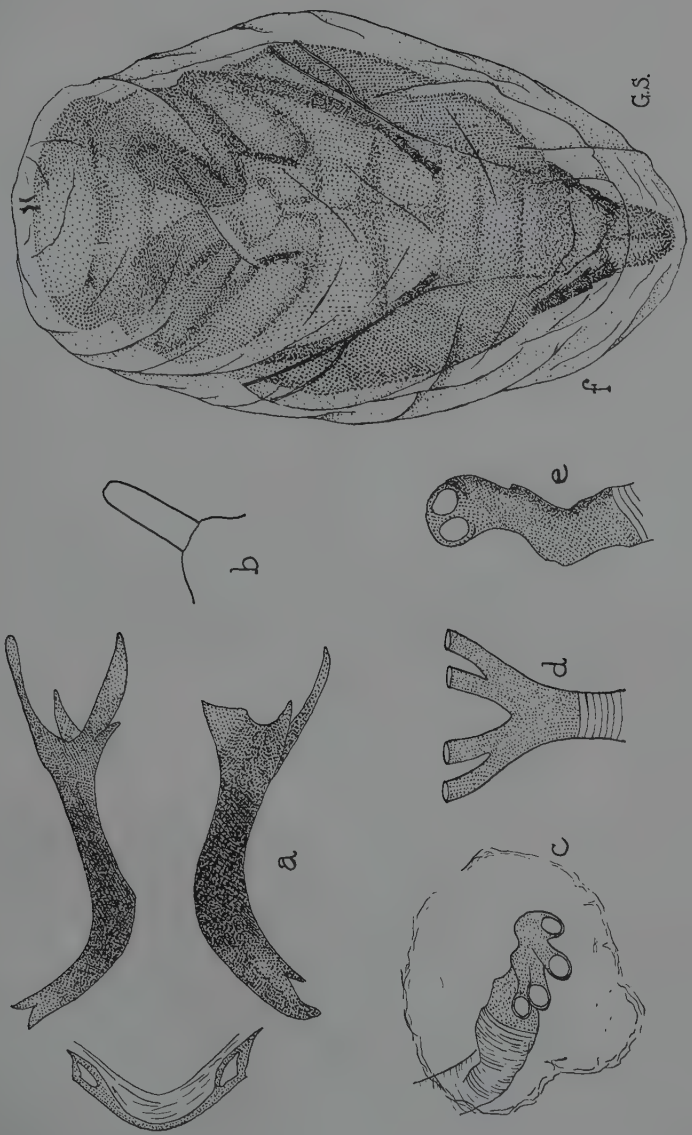


ETHOLOGY OF THE MELIPONINAE.

ON A NEW SENSE ORGAN IN CERTAIN LEPIDOPTERA

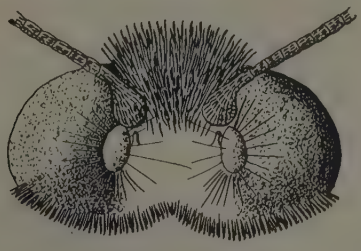
By H. Eltringham, M.A., D.Sc.

[Read October 2nd, 1929.]

With Four Text-figures.

In our *Transactions* for 1925, p. 7, I described the histological structure of an organ in the head of a moth (*Sematura empedocles*, Cram.). This organ had already been discovered by Dr. Karl Jordan, who described its external features in a paper in 1923, *Novit. zool., Tring.*, **30**: 155. He named it the Chaetosema.* The sections from which I gave an account of the organ were made from an example kindly preserved and sent to me by the late Dr. C. L. Withycombe. These sections showed the presence of another organ of much smaller dimensions, but also having an independent connection with the brain. I made no mention of the discovery when dealing with the nervous distribution of the chaetosema, as I hoped to obtain more material, and thus be enabled to work it out more completely than was possible with the single example then available. I have just received from Dr. Urich of the Department of Agriculture, Trinidad, another specimen of *Sematura*, and from preparations of this I had hoped to secure more trustworthy information as to the nature of the organ. Unfortunately, these preparations, although confirming and extending the results already obtained, do not throw any further light on the probable function of the organ. It seems desirable therefore to give some account of the structure pending a larger supply of material, and the possibly improved results of other methods of preservation.

Fig. 1 represents the head of the moth with the scales removed from the

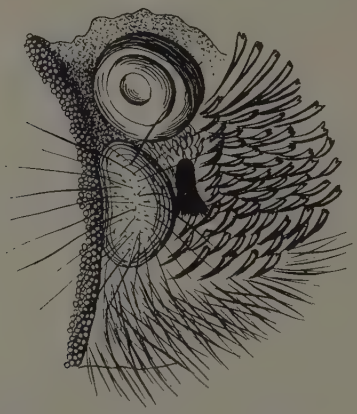


Text-fig. 1.—Head of *Sematura empedocles*, ♀, viewed from above.

post-antennal region. The chaetosemata are visible as oval convex bodies, just behind the basal attachment of the antennae. Close to the inner edge of each, there can be seen a small papilla arising from the chitin of the top of the head, and projecting forwards and slightly upwards. These two papillae are the organs in question. Normally they are completely covered by the

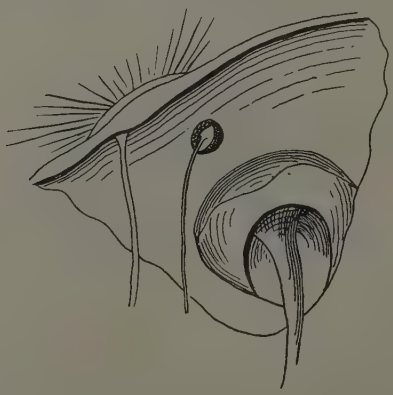
* In my paper above referred to the word was unfortunately misprinted chaetosoma.

scales of the head and cannot be seen until these have been removed. Fig. 2 is an enlarged view of this area of the head, and the organ appears black in the centre of the figure, the large rounded body in front of it being the socket



Text-fig. 2.—Chaetosematal area of head of *Sematura empedocles* showing papillate organ.

and base of the antenna. Fig. 3 shows the appearance of the same area from the inner side. On the upper left of the figure part of the chaetosema can be seen in profile with its nerve-cord passing to the underside. Below and to



Text-fig. 3.—As Fig. 2, but viewed from the inner side.

the right is the antennal socket and between the two is the delicate nerve running to the inner attachment of the papillate organ, itself shown in section in Fig. 4. Its outer surface is smooth and polished, and the chitin forming the papilla is comparatively thick and devoid of projections or any complicated

structure. Examination of a series of sections shows that there are, on the underside of the papilla (above and to the right in Fig. 4), several minute perforations or pores. These are, however, quite simple, and even under the highest magnification do not show any nerve-endings or other sensory apparatus. The nerve-cord passing from the brain to the organ is of the usual type, consisting of a bundle of fibres in a delicate nucleated sheath. Inside the papilla this cord expands into a rather amorphous mass of nerve tissue. The majority of nerve-endings in cuticular organs show considerable structural detail, but in this instance there is nothing to afford the least clue to the nervous function

Text-fig. 4.—Section through the papillate organ of *Sematura empedocles.*

of the apparatus. After treating with haematoxylin, which, as usual, stains the whole mass an intense black, the subsequent differentiation with iron alum merely results in the gradual clearing of the whole body from the periphery to the centre, leaving here and there a few dark granules.

Like the chaetosemata, the organs are present in both sexes, and occur also in *Urania fulgens* and *Chrysiridia ripheus*, though much reduced in the latter species. The definite nerve connection with the brain would seem to indicate a functional activity of the organ, but there is nothing in its simple, if not degenerate, structure to suggest what that function may be. It is buried in the general scaling of the head and so can be of no optical use. The moths in which it is found are already provided with auditory organs, and for the present its function must remain as great a mystery as that of the chaetosema itself.

AFRICAN RHOPALOCERA: DESCRIPTIONS AND NOTES

By Dr. Harry Eltringham, M.A., D.Sc.; Prof. Edward B. Poulton, D.Sc., F.R.S.; N. D. Riley, F.Z.S., F.E.S.; and G. Talbot, F.E.S.

[Read October 2nd, 1929.]

Plates XXX–XXXI and Two Text-figures.

We are indebted to the kindness of our friends Lord Rothschild, Ph.D., F.R.S., Dr. Karl Jordan, Ph.D., and Dr. F. A. Dixey, D.M., F.R.S., for the descriptions of three new forms, and also desire to thank the friends who have generously supplied the material without which this paper could not have appeared. Thinking that it might sometimes be inconvenient for the reader to be obliged to turn to the end of a description with the accompanying notes, for the author's name, the initials of the writer have been printed at the beginning. For the same reason they have been added to the descriptions of figures on Plate XXX.—H. E., E. B. P., N. D. R., G. T.

Amaurina ansorgei, E.M.Sh., neavei, subsp. n.

E. B. P.

This southern race is about the same size as *A. a. ansorgei*, E.M.Sh., but considerably smaller than *a. altumi*, van Someren. The basal patch of the hind-wing is, as in the latter race, a much paler yellow than in *a. ansorgei*. The absence, except for faint traces on the under surface, of the series of small pale submarginal dots on both fore- and hind-wing gives to the pattern a very different appearance from that of the two more northern races. These evanescent dots are rather more developed on the under surface of a female specimen.

Type: a ♂ (17 Dec. 1910); also 2 ♂♂ paratypes (16 and 17 Dec. 1910) from Iringu, 3000 ft., foot of Kifulufulu Mtn., Usangu Distr., Kilosa rd., Tang. Terr. (*S. A. Neave*); in Hope Department. Paratypes in British Museum—2 ♂♂ as above, 16 and 17 Dec.; 1 ♂ (20 Nov. 1910), slopes of Mt. Rungwe, 5–6000 ft., nr. New Langenburg, T.T. (*S. A. Neave*); 2 ♂♂, 1 ♀ Itumba district, T.T. (*Rev. G. Wood*); 1 ♂ (3 March 1896) Nyika, Kasungu Mountain, 7200 ft., Nyasaland (*R. Crawshay*).

The name *torrefacta*, le Cerf (the type from Molo, S.E. of Mau, Kenya Col.) appears to be a synonym of *A. a. ansorgei*, E.M.Sh. A paratype of *torrefacta* in the British Museum is from Lumbwa, Kenya Colony, and resembles *ansorgei* from the same locality. There is little doubt that the localities on Dr. Ansorge's specimens are inexact, and that the insects were taken on high ground to the W. of the Rift Valley. The type of *a. ansorgei*, now in the Tring Museum, is labelled "Lugumba's, Uganda, 30.xii.1894," another similar example in the Hope Department—"Pt. Alice, 30.vi.1894. Dr. Ansorge." Dr. R. van Someren kindly informs me that "Port Alice is the old and extinct name of Entebbe, and I knew a Lugumba as an unimportant lake-shore village west of Entebbe, which was wiped out by sleeping sickness, so it is practically the same locality as Entebbe. There might be another elsewhere, but I have never heard

of it. Dr. Ansorge came to Uganda in the pre-railway days, and must have walked up from Mombasa, and in so doing would doubtless pass through the Nandi country, but no doubt you will see this in his book." Dr. W. J. Ansorge is shown, in the volume referred to by Dr. van Someren—*Under the African Sun* (London, 1899)—to have passed over the Mau Escarpment and the Nandi country (p. 55), thus traversing the localities of *A. a. ansorgei*, which is represented in colour on his pl. 1, fig. 6. Its locality is given in the volume (p. 302) as follows :—" Caught at Chagwe * in Uganda on December 1894 near a stream." Miss E. M. Sharpe records " Uganda, Dec. 30, 1894 " in the original description (Aug. 1896, *Ann. Mag. Nat. Hist.*, (6), **18** : 158). Having seen many hundreds of specimens of the closely allied genus *Amauris* from Uganda, and especially the Entebbe district, without ever encountering one of the races of *ansorgei* among them, I have no doubt that Dr. Ansorge accidentally confused specimens taken in the higher country to the E. with one or more of the superficially similar Uganda Danaines.

The distribution of the races of *Amaurina ansorgei* so far as we know them at present is as follows :—

1. **Amaurina ansorgei ansorgei,** E.M.Sh.,—the high country of the Mau Range forming the W. boundary of the Rift Valley in Kenya Colony.

2. **Amaurina ansorgei altumi,** V. G. L. van Someren,—first taken in Nairobi itself (*Canon St. Aubyn Rogers*), later in abundance on the Katamyio River, Uplands, on the E. side of the Rift Valley. The life-history of this race is recorded in *J. E. Afr. Ug. Nat. Hist. Soc.*, **21** : 44, issued May 1926, with plate. Dr. V. van Someren informs me that *altumi* is the commonest *Amauris* along the S. Aberdares to Uplands on the Kikuyu Escarpment, at elevations of 6–8000 ft., also that forms intermediate in colour and size between *altumi* and *ansorgei*, but in both respects nearer the latter, occur at 8000 ft. in the Molo district, S.E. of Mau Station.

3. **Amaurina ansorgei neavei,** subsp. n.,—much further south, in Tang. Terr. and Nyasaland in the localities cited on p. 475. Generally at a lower elevation than races 1 and 2.

Euxanthe trajanus, Ward, **vansomereni,** subsp. n.

Pl. XXX, fig. 1, ♀.

E. B. P.

This rare Uganda race of *trajanus*, Ward, is excellently described and figured by Dr. V. G. L. van Someren and Canon K. St. A. Rogers, together with a full account of its life-history, in *J. E. Afr. Ug. Nat. Hist. Soc.*, **30**: 59–61, Pl. XLII, July 1927.

Having had the opportunity of comparing this race with the more western *t. trajanus* I have attempted below to give some account of the differences between their patterns.

Male fore-wing upper surface.—Distinguished from that of *t. trajanus* by the relatively small size of the pale yellow spot within the distal end of the cell and the consequent increase in the sienna-brown basal area. An Angola ♂ in the British Museum is somewhat intermediate in this respect. The conspicuous black line, along which runs the lower

* The province (on the N.W. of the Victoria Nyanza) including Kampala and Entebbe.

discocellular, narrows gradually to a sharp or blunt point at the junction with the median, but remains of nearly the same width and ends squarely in *t. trajanus*. This character is not quite constant, the male figured in the Uganda journal (*l.c.*) being exceptional, while an Entebbe male in the Hill Museum resembles *t. trajanus* in this respect and is also slightly intermediate in the somewhat greater size of the mark in the cell. The pale central band forming the most conspicuous feature in the F.W. pattern is narrower than in *t. trajanus*, the above-mentioned Angola ♂ being somewhat intermediate.

Male hind-wing.—The submarginal white spots are far more strongly developed and the basal patch generally larger. Of two Cameroon males in the Hope Collection one has a much smaller basal patch, the other being nearly equal to the Uganda race in this respect.

Female fore-wing.—The white central band is much less developed below the median and more sharply broken up into four distinct marks, in areas 1*a*, 1*b*, 2, and 3, respectively. Above the median the two elements of the ♂ band, in area 4 and the end of the cell respectively, become three in the female by the division of the latter mark. As compared with *t. trajanus* ♀, these three marks are greatly reduced and often obsolescent or rendered inconspicuous by dark scales. This reduction is far less apparent on the under surface, where the marks in the end of the cell are generally but not always fused as in the ♂ of both races and in *t. trajanus* ♀. A ♀ taken on Bugalla I., on 26 March 1925, by Dr. G. D. H. Carpenter is transitional in the width of the band and the strong development of the marks on the upper surface in and near the end of the cell.

Female hind-wing.—The basal patch is smaller and yellower and the marginal markings larger than in *t. trajanus*. In a single ♀ in the Tring Museum from Lucbo, Kassai R., the basal patch is even smaller than in the Uganda ♀ and the marginal pattern nearly as well developed.

The distinguishing characters of these races are very variable, especially in the female, but a comparison between the Uganda and more Western material in the British, Hill, Oxford and Tring Museums clearly shows that they are different geographical forms, doubtless transitional into each other in the intermediate area.

Type ♂, Paratype ♀ (Pl. XXX, fig. 1), from Mawakota, 80 miles W. of Kampala, Uganda (April 1924), (*V. G. L. van Someren*). In Hope Collection, O.U. Museum. Paratypes in British, Oxford, Hill (Witley), and Tring Museums.

Charaxes druceanus kivuanus, Jord. (1925), female.

E. B. P.

A beautiful *Charaxes*, taken 15 June 1916 by Canon St. Aubyn Rogers, on Dabida Mountain (*c.* 3700 ft.), about 100 miles W.N.W. of Mombasa, is, as Lord Rothschild and Dr. Jordan agree, the hitherto unknown female of *druceanus kivuanus*. The differences between this and the female *d. druceanus*, Butl., are almost restricted to the H.W. under surface, although the H.W. "tails" are much longer. Compared with two females in the Tring Museum, the upper surface is darker in tint than one of these (Durban) but about the same as the other (Transvaal).

Hind-wing under surface.—The anal eyespot and all the submarginal markings are more strongly developed and their iridescent blue centres far more so, than in the ♀ *d. druceanus*. The outer border of the main silver stripe is much straighter (in fact nearly quite straight), in this respect resembling Lord Rothschild's two males of *kivuanus* from the Rugege Forest at the south end of Lake Kivu, in S.W. Ruanda.

Ch. druceanus proximans, Joic. & Talb., is, together with its life-history, fully described and the male figured by Dr. V. G. L. van Someren in *J. E. Afr.*

Ug. Nat. Hist. Soc., **33–34:** 3–6, Pl. LXXIX, 1928. The author states on p. 6, that the form of this butterfly found on the Dabida Hills in Teita "apparently approaches the race *kivuanus*. Very few specimens have been recorded, and much remains to be learnt regarding its distribution. There is little variation in general colouration; there is, however, a tendency to paleness of ground-colour in some specimens and this results in a greater definition of the black markings."

Charaxes eudoxus, Drury, **amaurus,** subsp. n.

E. B. P.

Male upper surface.—As in the ♂ *e. cabacus*, Jord., in the Hope Collection, which has been compared with the ♂ type in the Tring Museum by Dr. Jordan.

Male fore-wing under surface.—The silver markings of *e. eudoxus*, reduced in *cabacus*, are far more reduced in *amaurus*, becoming smaller, losing the metallic lustre and assuming a faintly greyish tinge. The enclosed black markings are also smaller, this reduction being carried farthest in the large black mark in area 1*b*, which is divided into two widely-separated spots by the disappearance of the central section. The blue centres of the sub-marginal markings in areas 1*b* and 2 are also much reduced in *amaurus*.

Male hind-wing under surface.—The loss of brilliancy is as in the F.W., and the reduction of markings carried much farther. All that can be seen in this misty reproduction of the lustrous markings of other races is the basal stripe, and the irregular central stripe giving off two distal branches, one marking the position of the aborted lower discocellular, and the other crossing area 4. The outermost silvery stripe, joined by the distal ends of these branches and itself fusing with the central stripe at vein 7, is entirely wanting.

Female upper surface.—Nearly resembles that of a ♀ *e. eudoxus* from Sierra Leone in the Hope Collection, but the dark ground-colour beyond the tawny band is narrower in both wings, the orange-brown marginal spots of F.W. much larger, and the three dark orange-brown spots forming a band which crosses areas 5, 6 and 7, far more distinct. The lower marginal spots of H.W. and the two blue spots at the anal angle are much larger.

Female under surface.—The suppression of the markings is carried farther than in the male, especially in H.W., where a close inspection is required in order to detect the fine grey line which occupies the position of the basal stripe and the slight traces indicating in part the position of the silvery markings crossing the centre of the wing in *cabacus*. The female is somewhat worn and it is probable that these markings would be rather more distinctly seen in a fresh specimen.

Length of F.W.—Male, about 46·0 mm. from apex to centre of thorax, allowing for the somewhat worn tips; female, 48 mm.

Type: ♂. W. of Kitale on the E. slopes of Mt. Elgon, Kenya Colony, 24 Apr. 1924, V. G. L. van Someren. In the Hope Coll., Oxford Univ. Museum, together with the female paratype from the same locality, but captured 5 May 1924.

The specimen briefly described by Dr. Neave in *Nov. Zool. Tring.*, **11**: 335, 1904, almost certainly belongs to this race. It was taken by Mr. C. W. Hobley at Kamwezi.

The race *Ch. e. amaurus* appears to have been derived from *e. cabacus* modified by mimicry of the common *Ch. lucretius*, Cram. The name *amaurus*, suggesting the dimming of the characteristic silvery pattern of the under surface in other races of *eudoxus*, was proposed by my friend Prof. Fraser.

The relation of *Ch. e. amaurus* to *Ch. e. cabacus* is clearly stated by Dr. V. G. L. van Someren, 1928, *J. E. Afr. Ug. Nat. Hist. Soc.*, **33–34:** 6–8, Pl.

LXXIX, fig. 2, where the male of the latter is described and figured and the distribution given as "Uganda and the Nandi-Lumbwa districts of Kenya." In the country "north-east of Mt. Elgon to the Cherangani Mts." *cabacus*, it is stated, is replaced by another form (here described as *amaurus*). The relation between the two races is explained as follows:—"We have already noted the association of this species [*cabacus*] with *Ch. lucretius* and *Ch. druceanus*, but we would draw attention to the description of the form to be described hereafter which not only bears a strong likeness to *lucretius on the upper side, but also below*" (p. 8).

The "general colour above is as in *Ch. eudoxus cabecus* [*cabacus*]. Both sexes however differ from the typical form of other described races, in that practically all trace of the silvery-white lining on the underside is lost, thus strongly resembling *lucretius*. In addition, there is a marked reduction in the size and alteration of the shape of the spots in areas 1*b* and 2; thus in the male, there are two separate black spots in each of these areas, and in the female the spot in 1*b* is L-shaped. The hind-wing in the male is almost unicolorous chestnut" (p. 8).

Very few examples of the rare and beautiful *Charaxes eudoxus* were known when Rothschild and Jordan published their great monograph in 1900, and it is therefore appropriate to compile a list of the specimens of the four races now preserved in the British, Hill, Hope and Tring Museums. *Ch. e. fallax*, Richel., now known to be a distinct species, is omitted from consideration.

1. **Charaxes eudoxus eudoxus,** Drury.—A single male from Sierra Leone (Crowley Bequest, 1901) is present in the British Museum.

In the Hope Coll. a male bears the label "*Eudoxus* Drury, pl. 33, fig. 1, 2" in the MS. of Prof. Westwood. Also a note written by Roland Trimen:—"5.vii.1897. See A. G. Butler's note (J. Linn. Soc. Zool., [**25**], 1896, p. 352) that 'up to the present time Drury's figures are all that remain to show us what this species is like.'" * A second male and a female were taken in 1910 by the late Lt. C. A. Foster, at Regent, about 3 m. S.E. of Freetown, Sierra Leone. The F.W. discal band, long in both males, is prolonged nearly to the costa in the older specimen. The silvery markings of the under surface are most highly developed in this race.

Mr. Talbot has kindly examined a dissection of the genitalia of the above male from Regent, prepared by Mr. Bennett, who has also made the drawings of this and the two other forms, represented in the text-figures on page 480. Mr. Talbot reports as follows:—

"*C. e. eudoxus.*—*Valve* very strongly sclerotised. Apex strongly curved and pointed. Dorsal fold broad and well-developed. *Penis* not examined as it was damaged in the specimen dissected. This organ is frequently found extruded after death and is therefore easily damaged.

"*C. e. mechowi.*—*Valve* less strongly sclerotised. Apex narrower and less strongly curved. Dorsal fold narrower. *Penis* narrow and unarmed.

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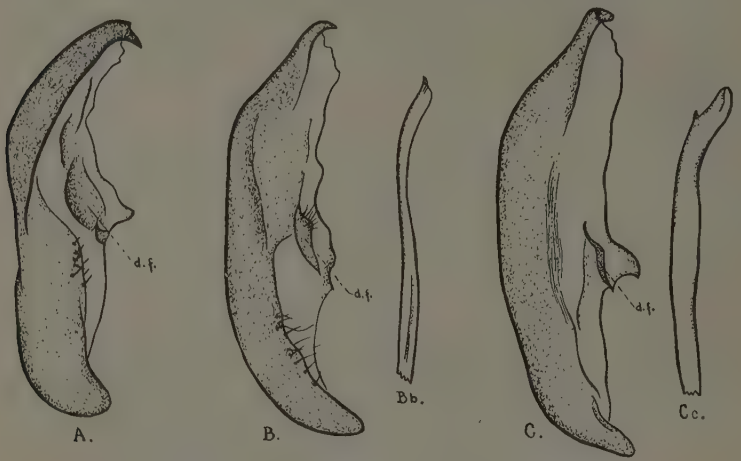
* This specimen is referred to in 1900, *Nov. Zool. Tring.*, **7**: 419, together with "a ♂ from Buea, Cameroons, in Dr. Staudinger's collection; [and] a specimen from Aburi, Ashanti, in the Senkenbergische Museum at Frankfort-on-the-Maine."

"*C. fallax.*—Valve much less sclerotised than in *eudoxus* forms. Apex obtuse, the extremity at about right angles to the plane of the valve. Dorsal fold much narrower than in *eudoxus* forms. *Penis* about twice as broad as in *eudoxus* forms, and with a short and broad triangular spine placed laterally a short distance from the apex."



A—*Charaxes eudoxus*, valve; B, Bb—*C. eudoxus mechowi*, valve and penis; C, Cc—*C. fallax*, valve and penis; d.f.—dorsal fold.

2. **Charaxes eudoxus mechowi,** Rothsch. (Oberth. i. l.).—The silvery markings less than in *e. eudoxus*, but more pronounced than in the following races. The orange tawny discal band of F.W. arises with a broad base on the inner margin and tapers into very small spots, varying greatly in number and therefore in approach to the costa. In the H.W. the tawny border and discal band are broader than in *cabacus*.

British Museum.—3 ♂♂ respectively from Kamerun, Buar (10–29.v.1914); Camerun, Sardi, nr. Dengdeng (9.iv.1914); Belgian Congo, Fayala, R. Wamba, E. Torday. This last exhibits a probable beak-mark on the L.H.W.

Hill Museum.—16 ♂♂, 1 ♀ from the following localities:—*Cameroons*: 1 ♂, Bitje, Ja River, 2000 ft., wet season, iv, v, 1912 (*G. L. Bates*); 2 ♂♂, ditto, dry season; 1 ♂, ditto, early May and June; 2 ♂♂, Sakbayeme, Edea, March 1922 (*C. Schwab*); 2 ♂♂, ditto, no date. *Congo*: 1 ♂, Lubutu River, Lowa Valley, 2800 ft., Aug. 1921 (*T. A. Barns*); 1 ♂, Lindi River, 20 miles above Bafwasende, 2300 ft., July 1921 (*T. A. Barns*); 1 ♂, Forest on watershed of Ituri and Lindi Rivers, S.W. of Avakubi, April 1920 (*T. A. Barns*); 1 ♂, Kassai River, ex Coll. Suffert; 1 ♂, Semliki River, ex Coll. Suffert; 1 ♂, Ponthierville, Wanie Lukulu, Moorgui, 24.iii.1924 (*Major Briggs*); 1 ♂, Lusombo, Ludega, 1924 (*Major Briggs*); 1 ♂, Lulanga, ex Coll. Suffert. 1 ♀, *Angola*: 1 ♀, ex Coll. Gr.-Sm.

Hope Collection, Oxford Museum.—1 ♂, Bafaka (26.vi.1929) 25 miles W. of Bongandanga, Basankusu, Belgian Congo (*Miss G. Vinall*).

Tring Museum.—8 ♂♂, of which 7 are from Ja River, Cameroons, and 1 from W. of L. Tanganyika, between Niembo and Kalembo.

3. **Charaxes eudoxus cabacus,** Jord.—The discal band of F.W. is comparatively short, extending to about half the distance between the inner margin and the costa in four examples at Tring. In the fifth and the Oxford specimen it extends farther. The terminal spots in areas 5 and 6 of the latter are very small.

British Museum.—2 ♂♂ 1 ♀: 1 ♂, Entebbe, Uganda, 1905 (*E. A. Minchin*); 1 ♀, Tero Forest (3800 ft.), S. E. Buddu, Uganda, 26–30.ix.1911 (*S. A. Neave*); 1 ♂, Yala R., S. edge of Kakumega Forest (4800–5300 ft.), Kenya Col., 21–28.v.1911 (*S. A. Neave*). This male exhibits symmetrical injuries to H.Ws. and a probable beak-mark on the L.F.W. It also bears the MS. note—"Injured before capture." The underside of this specimen differs somewhat from that of *cabacus*, but its locality falls into the area of the latter as defined by Dr. V. G. L. van Someren (p. 479), so that it is reasonable to consider it, on the only available evidence, as a variety of this race.

Hill Museum.—*Uganda*: 1 ♂, Entebbe, Aug. 1901 (*A. H. Neumann*); 1 ♂, Entebbe, June 1900 (*Capt. Rattray*); 1 ♂, Entebbe, ex Coll. Grist. *British Cent. Afr.*: 1 ♂, Keriche, July 1903. 1 ♂, *No loc.*

Hope Collection.—The single male of *cabacus* taken in March 1903, in the Tiriki Hills, about 20 miles from Kisumu, N.E. Victoria Nyanza, by Major C. A. Wiggins, C.M.G., is described as *e. mechowi* by Dr. S. A. Neave, in 1904, *Nov. Zool. Tring.*, **11**: 334, 335.

Tring Museum.—*Uganda*: 4 ♂♂, Entebbe; 1 ♂, Kampala.

4. **Charaxes eudoxus amaurus,** subsp. n.

The only typical examples in the four museums are the ♂ and ♀ from Kitale in the Hope Collection (p. 478), but a ♂ transitional towards *cabacus* is labelled "Uganda" in the Hill Museum.

Charaxes xiphares reducta, subsp. n.

Lord Rothschild.

[The description of this interesting southern race has been kindly written by Lord Rothschild after studying all the available material in the four museums.]

There are in the coastal areas of Southern Africa, two forms of *Ch. xiphares*, a western and an eastern one; but apparently in the intervening areas not only intermediate examples occur, but in localities often of very restricted area typical western forms occur in the east and vice versa. This is probably due to the particular area having similar conditions to those of the topotypical area of the forms. However, *Ch. xiphares*, considering that it has been known for almost 150 years, is so rare in collections, and of the 50 odd specimens in Great Britain so few have accurate data that the question of the intermediate examples and the typical individuals of both races taken in the various intermediate areas must be left for solution till the species has been extensively bred.

♂. Above. Differs from *xiphares xiphares* in the V-shaped series of discal spots being much smaller and in the marginal streaks being more distinct and yellower; on the hind-wing the marginal lunules are orange NOT blue. Below. Differs in being deeper olive-brown on all four wings, in the broad white bands being reduced to narrow but sharper lines and the black lines being very distinct; the white patch behind the tornal ocelloid patch is entirely absent on the fore-wings, and on the hind-wings the olive-yellow markings are more sharply defined.

♀. Above. Has the post-median line of pale spots on the fore-wings obsolescent and only the three spots nearest the costa well defined. Below. The white areas are more restricted and the olive-brown ground-colour darker; the chief difference, however, is that while in *x. xiphares* there is a broad distinct comma-shaped white patch behind the ocelloid tornal patch, in *x. reducta* it is almost absent.

Habitat : W. Pondoland.

There are now 5 races of *Charaxes xiphares* described :—

Ch. x. xiphares, Cram., Western South Africa.
Ch. x. reducta, Rothsch., Caffraria (sensu restr.); Natal?
Ch. x. kenwayi, Poult., Haenertzburg, Zoutpansberg district.
Ch. x. nandina, Rothsch., Nandi Country, E. Africa.
Ch. x. wernichei, Joic. & Talb., Cameroons.

Typical *xiphares xiphares*, however, appears to occur as far east as Natal in certain restricted areas; while *x. reducta* and more or less intermediate forms occur as far west as Knysna, if the data on some of the older examples are correct.

Charaxes xiphares kenwayi, Poult., 1929, ♂.

E. B. P.

This interesting race was described (1929, *Proc. Ent. Soc. Lond.*, **4**: 48, footnote) from two females presented to the Hope Collection by Mr. H. Cecil Kenway, who has now kindly added the male and a third female.

Male upper surface.—Resembles *x. xiphares*, Cram., except that the central blue band of H.W. is somewhat broader.

Male under surface.—Closely resembles 2 males of *xiphares reducta* from W. Pondoland and 1 from Natal in the Tring Museum, but the colour is rather darker and a little less diversified with lighter shades. Compared with 10 males of *x. nandina* in the Oxford and Tring Museums the colour has less of a yellowish tinge and the markings are more slender and delicate.

Length of ♂ F.W.—44·5 mm. (apex to centre of thorax) as compared with 49·0 in a ♂ of *x. xiphares* from Caffraria and an average of almost exactly 51·0 in 5 ♂♂ of *nandina* from the Nairobi district, in Hope Coll.

From Haenertzburg, Zoutpansberg district, 1 December 1924 (*H. C. Kenway*).

The female with the same data as the male closely resembles the type ♀ specimen, but is considerably larger—55·0 mm. as compared with 49·5 in length of F.W. The large spot in area 2 of F.W. upper surface is prolonged outwards into the line of the postdiscal series, a feature (present but not so strongly marked in the ♀ type and paratype) which distinguishes this race from both *xiphares* and *nandina*. The yellow line within the margin of H.W. is narrower than in the other two ♀ *kenwayi*.

Charaxes guderiana, Dew., **rabaiensis,** subsp. n.

E. B. P.

♂.—A single specimen from Kaya Kauma, Kenya Col., differs from *g. guderiana* in the following features :—*F.W. upper surface.*—The last spot of the postdiscal series is but faintly

indicated by a patch of blue scales in area 1*b*. *H.W. upper surface.*—A great reduction of the blue postdiscal band and submarginal dots of which the white centres are wanting or obsolescent.

The above-mentioned characters are very variable, but no male of the long series in the Hope Collection shows so marked a departure from the normal form of *g. guderiana* as this example from Kaya Kauma.

♀.—The basal area of both F. and H.W. upper surface is brownish-black instead of hazel-tawny as in *g. guderiana*, and all the markings are a dull cream-colour (the postdiscal series of F.W. being a rather deeper shade), instead of buff yellow. In addition to these differences in colour, the spots of postdiscal series of the F.W. are somewhat, and the spot in the apex of the F.W. cell greatly, reduced in size. There appears to be no marked difference on the under surface.

The general effect of the different colouring in the female is to promote a resemblance to *Ch. castor flavifasciatus*, Butl., and to *hansali baringana*, Rothsch., rather than to *pelias saturnus*, Butl.

Type: ♀. Rabai, April 1928 (*V. G. L. van Someren*). In Hope Coll.

Paratype: ♂, Kaya Kauma (*c.* 600 ft.), about 35 miles N. of Rabai, 13 March, 1906 (*Canon K. St. Aubyn Rogers*). In Hope Collection.

I am informed by Dr. V. van Someren that this female form is characteristic of the coastal area of Kenya Colony. For this reason the female and not the male is made the type of the race. Some of the Oxford Museum examples of *g. guderiana* from Tanganyika Territory are transitional towards *g. rabaiensis*. Thus a female, taken 6 Mar. 1917 at Tamé River (*c.* 2500 ft.), 15 miles E.N.E. of Mamboya, by Canon Rogers, is intermediate in the tint of the F.W. band and the size of the postdiscal spots, and in the slightly darkened hazel-tawny of the bases in both wings. A series of 8 males from Kongwa, near the railway, about 210 miles W. of Dar-es-Salaam, taken Feb.–Aug. 1917, by Canon Rogers, is also transitional in the reduction of blue in the H.W. postdiscal spots.

Charaxes etheocles, Cram., ♂-f. n. **lenis.**

Karl Jordan.

[We are indebted to our kind friend Dr. Karl Jordan for describing this interesting male form of *etheocles*.]

Upperside of both wings velvety-black with a distinct blue tone. On fore-wing a dot before apex of cell and another beyond it light blue, no submarginal spots, at margin a row of rather large dull glaucous spots which are wider at the margin than their interspaces, the middle spots almost touching each other. On hind-wing an indication of a diffuse narrow bluish postdiscal band, more or less lunate posteriorly, a complete submarginal row of white spots shaded with blue, admarginal bars reddish-orange from anterior tail forward, with a shade of glaucous, more or less glaucous from anterior tail to anal angle.

Underside nearly as in ♂-f. *cytila*, Roths., 1900, ground almost uniformly reddish-brown, with a strong reddish-purple sheen, the black bars thin, particularly those of hind-wing.

Mulange (1.i.1921), 2 specimens (*V. G. L. van Someren*).

Type: Mulange, Mabira Forest (3400 ft.), Uganda, 1 Jan., 1921; (*V. G. L. van Someren*). In Hope Dept., O.U. Mus. Paratype with same data in Tring Mus.

Euphaedra preussi, Stgr. (1891), **sordida,** subsp. n.

G. T.

Allied to *olivacea,* Grünb. (1908); much darker, and with a row of submarginal spots on the hind-wing.

♂.—Resembles *olivacea,* but is more bluish-green. Fore-wing above with the median area to the subapical band blackened. Subapical band very narrow, white, and more oblique than in *olivacea,* the two middle spots longer than in this form, the one in 4 extending more distad. Hind-wing with a weakly-defined black distal border bearing a series of bluish-green submarginal spots.

Underside olivaceous mixed with ferruginous, darker than in *olivacea.* Fore-wing in the submedian area dusted with bluish-white. Hind-wing with a postdiscal band of white stripes, the anterior three nearly equal, the posterior three short and narrow; some of these stripes almost touch the submarginal bluish-white spots; the usual white subcostal stripe is partly broken by the ground-colour near its middle.

Paratype differs as follows :—Upperside with ferruginous dusting over the median area of fore-wing and discal area of hind-wing; submarginal spots obsolete, only the anterior two distinct; no dark distal border. Underside of fore-wing still darker than in the type, with the submedian area but slightly paler than the rest. Hind-wing with postdiscal stripes faintly marked.

♀.—Upperside of fore-wing with proximal half violet-blue, distal half black-brown. White subapical band a little broader than in *olivacea* and agreeing with the male in its shape, the more distal extension of the stripe in 4 always distinguishing this band from the one in *olivacea.* Hind-wing violet-blue excepting a black-brown distal border; a submarginal row of violet-blue spots.

Underside ferruginous marked with bluish-white. Fore-wing dusted with bluish-white over the median and submedian areas. Hind-wing very strongly marked with bluish-white; a postdiscal band is merged with a white proximal area, and distally extends to the bluish-white submarginal spots. The bluish-white subcostal stripe is almost broken near its middle by a dark patch, and vein 8 is striped with blackish.

Paratype differs as follows :—The violet-blue colouring remaining only as a gloss over the basal and costal area of fore-wing. The areas which are violet-blue in the type are dark ferruginous-brown. Underside of hind-wing with the bluish-white colour confined mainly to the postdiscal band.

Types ♂ ♀, and ♀ paratype in Hope Coll., O. U. Mus.; ♂ paratype in Nairobi Mus.

Hab.—Mawakota, Uganda, June, 1926, 2 ♂♂ 2 ♀♀ (*V. G. L. van Someren*).

Euphaedra preussi, Stgr. (1891), f. n. **lacteata.**

G. T.

Distinguished from other forms by its bluish-white coloration. Probably a phase of the previously described race.

♀.—Fore-wing above with proximal area bluish-white faintly dusted with yellowish-brown, extending in one specimen into cellule 3, and occupying the usual blue or brown area seen in all *preussi* and *eleus* forms. The distal black-brown area is shot with deep blue. A subapical band of four white spots, the one in 4 somewhat oblong in the type, and narrower and more oblique in the paratype. Hind-wing of the same colour as proximal area of fore-wing. A broad black-brown marginal border as in *eleus,* Drury, bearing a series of eight white spots which are slightly edged with blue proximally.

Underside ferruginous, paler over the areas which are white on the upperside. Cell of fore-wing with 2 black spots in the middle, a black point near its base and 2 black dots against the discocellulars in 4 and 5. Hind-wing with broad white subcostal stripe almost reaching the submarginal spot in 7, traces of white postdiscal patches, a black dot in cell below origin of vein 7, and submarginal spots as above, edged with bluish-black proximally.

The paratype differs in its coloration and markings on the underside. The white areas of the upperside are reproduced except that the cell and the stripe in cellule 2 of the fore-wing are yellowish-brown. On the hind-wing is a weakly marked broad discal band of the ground-colour. Black dots are absent on both wings. Cell and submedian area tinged with yellow-brown.

♂.—Upperside coloration similar to the ♀. Fore-wing with the basal area dusted and tinged with green. Two small rounded black spots in middle of cell; subapical band narrower than in the ♀. Underside similar to the ♀ paratype. Fore-wing with the two black cell-spots as above, the lower one obsolete. Hind-wing with the discal band strongly marked.

Types ♀ and ♂ (Allotype) in Hope Coll., O.U. Mus.; ♀ paratype in Nairobi Mus.

Hab.—Uganda, Toro, E. (Brit.) side Semliki Valley, Buamba Forest, the eastern edge of Congo Forest. Dry season usual but very rainy; 28.vii.21, *c.* 3000 ft., primary forest (*G. D. H. Carpenter, C. A. Wiggins,* with two "boys"*), 1 ♀ (Type). Exhibited, as a white variety of *E. eleus*, by Dr. G. D. Hale Carpenter, *Proc. Ent. Soc. Lond.*, 17.x.23 (p. lxiv.), **1923**. 1 ♂ (Allotype), 1 ♀ (Paratype), Mawakota, Uganda, June, 1926 (*V. G. L. van Someren*).

Euphaedra eleus, Drury (1782), **latifasciata,** subsp. n.

G. T.

This represents the intermediate form between *eleus congoensis*, Schmidt (1921), and *eleus orientalis*, Roths. (1898), which is the extreme eastern form and possibly not an *eleus* at all.

♂.—Subapical band of fore-wing broad as in *orientalis*. The brown proximal area of fore-wing as dark as in *congoensis* and extending into the base of cellule 3. Submarginal spots of hind-wing larger than in *orientalis*. Veins striped with bluish-black as in other *eleus* forms excepting *orientalis*, in which the veins are of the ground-colour. Black cell-dots on the fore-wing mostly present.

Underside coloured as in *orientalis*, being lighter than in *congoensis*. Hind-wing with a small white discal patch; the small rounded submarginal spots are of even size, in other forms the lower ones are larger.

♀.—Similar to *congoensis*, but the subapical band much broader, and submarginal spots on hind-wing larger, the anal ones a little larger than the others.

Hab.—Uganda: Mawakota, January, 1923, 1 ♀ (allotype), *V. G. L. van Someren;* Mabira Forest, Kyagive, Mulange, April–August, 1919 (*R. A. Dummer*), 1 ♂ (Type) in Hope Coll., and 4 ♂♂ 1 ♀ in Coll. Hill Mus.; Mabira Forest, September, 1921, 1 ♂, and Jinja, April, 1926, 1 ♂ (*V. G. L. van Someren*); Entebbe, 1 ♂ in Coll. Hill Mus.

* Major C. A. Wiggins, C.M.G., wrote on 27 October 1921 :—"The white *Euphaedra* was settled on the ground among about 40 others, so I singled it out for capture and never saw it on the wing at all."—E.B.P.

Euphaedra neophron, Hopff. (1855), **littoralis,** subsp. n.

G. T.

♂♀.—Markings as in the typical form. Distinguished by its violet-blue colour, which is darker than in *violacea*, Butl. (1888), from the Taveta district.

Hab.—Coast district of East Africa. Type ♂ from Rabai, 20.vii.1920, paratypes 3 ♂♂ from Chwaka, Zanzibar, 19–22.viii.1928, in the Hope Coll., O.U. Mus. Paratypes in the Hill Mus. from Mombasa, 5 ♂♂ 2 ♀♀ (♀ allotype), Zanzibar, 1 ♂. This race is represented as an aberration by a ♀ from Mhonda, Tanganyika Territory, in the Hill Mus., the remainder of the series from this region being typical *neophron*.

Neptis metella, Doubl., f. n. **vinalli.**

H. E.

♂.—Expanse 48 mm.

Upperside, ground-colour dark sepia, with white markings. F.W. In cell a long white streak pointed at base, sharply defined by median nervure and extending beyond end of cell. On the costal side this streak is less well defined and is rather deeply invaded by the

ground-colour for the basal two-thirds of its length. Above the distal end of this streak two minute dots, followed by an irregular discal series of very small spots, one in 1*b*, and two in 2, 3, 4, 5, 6, and 8. This series is followed by a band of ground-colour about 2 mm. wide divided by the paler scaling of the nervules into eight spots. The marginal pattern consists of three white lines (including the narrow white fringe) more or less interrupted in areas 3 and 6. Below the submedian, and about 3 mm. from the base, there is a small spot rather darker than the ground-colour. H.W. Following the dark basal portion there is an obsolescent discal white band, consisting of suffused spots in 4 and 5, mere indications of white in 2 and 3, but well marked in 1*a*, 1*b*, and 1*c*. The lower or distal edge of the band is curved sharply downwards towards the inner margin in areas 1*a* and 1*b*. This obsolescent discal band is followed by two series of dark internervular markings, the first small, the second consisting of much larger, rather conspicuous, more or less rounded spots. A submarginal row of obsolescent white spots, and two fine pale marginal lines (including the fringe).

Underside. F.W. Costa above cell at base, ochreous. Cell creamy-white, darker near subcostal. Discal area olive-ochreous with a rather complicated series of dark sepia and creamy-white spots, followed by a band, 1 to 3 mm. wide, of the lighter colour, divided into spots by the nervures, and nearly completely interrupted at area 3. A submarginal row of narrow, dark, internervular spots followed by a whitish margin with dark fringes in areas 3 and 6. H.W. Creamy-white, the base, to end of cell, pale olive-ochreous with black spots.

Beyond this a curved band of the ground-colour corresponding with the paler marks on upperside, followed by two curved rows of black spots, 2 in each area, on a pale olive-ochreous ground. The margin creamy-white with a narrow but distinct dark submarginal line broken into spots by the nervules, and a very faint dark marginal line. The accompanying text-figure is from a photograph of the specimen.

Body dark sepia above, creamy beneath. Antennae tipped with sienna.

TYPE: 1 ♂, in Hope Coll., 12.ix.1928, Baolongo, a village 40 miles W. of Bongandanga, Basankusu, Belgian Congo (*Miss Gertrude Vinall*).

The specimen is the only one received amongst a large collection made by Miss Vinall in the locality named. Though the example is a male, I have not made a preparation of the armature, since the structure of the organs in *metella* does not readily distinguish that species from others apparently related to it. That the specimen is a form of *metella* seems highly probable from the characteristic white mark in the F.W. cell on upperside, and the olive-ochreous markings of the underside. It differs from typical *metella* in the obsolescent state of the discal white markings of both wings above, and in the position of the discal black markings of the H.W. beneath, which are much nearer the middle of the wing than in *metella*. Typical *metella* has not so far been received from this locality, and the present form may prove to be a subspecies.

Neptis rogersi, Eltr. (1921), male.

H. E.

Eltr., Ent. Mon. Mag., (3), **7**: 29 (1921); Trans. Ent. Soc. Lond., **1922**: 568, Pl. XXI, f. 9.

♂.—The original description of this species was made from female examples only. Dr. van Someren has recently sent to the Hope Department at Oxford two further examples of the species, one of which is a male. In appearance it resembles the female, but is rather smaller. The acquisition of this specimen has made it possible to examine the genitalia with the interesting result that the species would appear to be allied to *Neptis seeldrayersi*, Auriv. In *seeldrayersi* the male claspers are very characteristic, as may be seen on reference to *Trans. Ent. Soc., Lond.*, **1922**, Pl. XXV, figs. 5 and 6. There is, on the inner side of the clasper, a peculiar hook-like structure not found in any other African species of *Neptis*. In *rogersi* there is no hook, but a small pointed chitinous projection sufficiently like the hook in *seeldrayersi* to denote affinity, though distinct enough to separate *rogersi* from that and other species.

Rabai, Coastal region of Kenya Colony, May, 1928 (*V. G. L. van Someren*).

Neptis trigonophora f. n. **vansomereni.**

H. E.

Expanse about 50 mm.

Upperside. F.W. sepia-black. A large white pyriform mark in cell, rather indistinct basally. Just beyond this, at end of cell, a minute white dot. A discal band of white spots, one in outer half of area 1*a*, about 5 mm. long, reaching inner margin and nervule 1. This is followed by, and contiguous with, a smaller more ovate spot in 1*b*. This does not touch nervule 2. In areas 2 and 3 two large white spots nearly separated distally by a wedge of the ground-colour. In area 4 a very small triangular distally placed spot. A band of elongated white spots in 5, 6, and 9, the last small, narrow, and nearly reaching the costa. Just beyond these discal spots a faint line of whitish scaling, rather deeply indented in area 1*b*. A series of three fine white submarginal lines interrupted only by the nervules,

and parallel except towards the apex, where they diverge slightly. Fringes white between nervules. H.W. sepia-black with a white discal band about 5 mm. wide extending from inner margin to join the inner-marginal white of fore-wing. Beyond this a pale line on the ground-colour, followed by three fine white submarginal lines corresponding with those of the fore-wing. Fringes white between nervules.

Underside. F.W. as on upperside but paler, and white markings more distinct, especially he submarginal lines which are broader and whiter. H.W. as on upperside but the basal costal margin is white, followed by two curved white lines on the basal black, the second of which is somewhat discontinuous at the upper or costal end. White discal band broader than above, the pale line and the submarginal lines broader and more distinct. Head, thorax, and abdomen, black above, whitish beneath.

Type ♂ and 4 ♂ paratypes in Hope Coll., Jinja, Uganda, May, 1921 (*V. G. L. van Someren*).

The structure of the genitalia is the only critical factor which enables me to relegate this form to the species *trigonophora*, Butl. The clasper of this species is quite peculiar and easily distinguished from that of other African species of *Neptis*, with the exception of *Neptis kikideli*, Boisd., which is only found in Madagascar. The outer facies of the *vansomereni* form differ from those of typical *trigonophora* in the well-developed white mark in the fore-wing cell; from *melicerta*, Dru., in the large inner-marginal white marks of the fore-wing; and from *strigata*, Auriv., in the small triangular spot in F.W. area 4.

Neptis roberti, sp. n.

Pl. XXX, fig. 9.

H. E.

♀.—Expanse 52 mm.

Upperside. F.W. sepia-black with white spots. Three minute streak-like spots in cell (one above middle of submedian, and two on line of discocellulars). One ill-defined discal spot above nervule 3, and one above 6. Three submarginal rows of small ill-defined spots, the outermost row obsolescent below nervule 4. Marginal internervular white spots on fringe. Beneath submedian and about 7 mm. from base, a white, distally tapered streak, and above this in area 2 a small suffused white spot. H.W. sepia-black with a small elongated white patch between 1*a* and 1*b*. Inner margin narrowly white. Three submarginal rows of progressively narrowing white spots, the two outer rows bifid. The margin deeply scalloped and with internervular white marginal lunules. A discal band of pale markings on the ground-colour.

Underside. F.W. similar to upperside but ground-colour slightly paler, and spots larger and better defined. Base of costa white. Cell with a white streak at base and a broken streak across middle. H.W. similar to upperside but ground-colour rather paler, submarginal spots larger and well defined. Inner row well rounded, and discal row of pale markings more distinct. A curved basal-costal tapered white mark, and beneath it a nearly parallel but shorter white mark. Beneath this an irregular and broken series of white spots. The white patch between 1*a* and 1*b* is smaller than on upperside. Palpi white beneath. Head, thorax, and abdomen black with white dots. Abdomen white beneath.

Type: ♀, in Hope Coll., from Mulange, Mabira Forest (3400 ft.), Uganda, January, 1922 (*Robert A. L. van Someren*).

Quite unlike any other species of *Neptis* known to me. Unfortunately a ♂ has not yet been received, so that I am unable to compare the structure of the genitalia with that of known forms.

Pseudacraea eurytus, L., f. n. **victoris.**

Pl. XXX, fig. 3.

H. E.

♀.—Expanse 80 mm.

Upperside. F.W. sienna-brown. Apex, for a depth of about 5 mm. sepia-black. A discal band of sepia-black invading the ground-colour from hind angle diagonally across area 2, and base of areas 3 and 4 as far as nervule 5. Base of cell occupied by an elongated black spot bearing two minute white dots. Three other black spots in cell (one 8 mm. from base and near subcostal nervure, the second above and slightly basal from origin of nervule 2, the third small and indistinct, near subcostal nervure and about 3 mm. from distal point of cell). A small spot below median, midway between base and origin of nervule 2. H.W. sepia-black at margin, shaded proximally to leave a rather narrow cream-white discal band. This band more sharply defined proximally by a deep madder-brown basal suffusion. Black basal spots as follows :—2 between submedian and median, 3 in cell (one at base with a whitish dot, one below middle of subcostal, and one near middle of cell), a minute dot on discocellular, one between nervules 6 and 7, close to their origins; a small spot, showing through from underside, between nervules 5 and 6 and near their origins. Nervules and internervular rays deeply marked black.

Underside. F.W. markings similar to upperside but ground-colour dull orange, and sepia rather paler. Spots similar but more distinct and with the addition of a spot on lower discocellular. H.W. similar to upperside but colours rather paler and basal red-brown brighter. Palpi yellow beneath, tipped with black. Thorax black with pale spots. Abdomen black above, yellow on sides with black rings, yellow beneath.

Type : ♀, in Hope Coll., from Mt. Marsabit, S.E. of Lake Rudolph, July, 1923 (*V. G. L. van Someren*).

Planema elgonense, Poult. (1927), **toroense,** subsp. n.

E. B. P.

A male and female of this *Planema* were taken in Kibale Forest, near Fort Portal, Toro, W. Uganda, 2 January 1928, by Dr. G. D. H. Carpenter. It is impossible, without further material, to decide whether they belong to a geographical race of *elgonense* from N.E. Uganda (1927, *Proc. Ent. Soc. Lond.*, 2 : 37), or whether the female of this species is dimorphic, the second form being represented by the Kibale specimen. This latter interpretation appears to be improbable in the genus *Planema*.

♂. *Upper surface.*—The orange F.W. band a little broader than in *elgonense*, especially in the areas between 3 and the costa : the serrations rather less marked except that in area 3 which is equally prominent. The parallel linear markings in 1*b* very distinct but not prolonged inwards so far as in *elgonense*. The H.W. very similar to that of the latter.

♀. *Upper surface.*—F.W. band orange instead of white as in *elgonense*. The pattern differs slightly from the latter much as does that of the male, the band being broader towards the costa and the serrations less marked than in the more eastern female.

Female under surface. The basal triangle of H.W. extends a little further distally and is straighter viz. less indented and irregular than in *elgonense*, but the tint and the spots are similar.

The ♂ under surface does not exhibit this slight difference.

The ♂ rather smaller, the ♀ rather larger than the corresponding sexes of *elgonense*.

Type ♂ and paratype ♀ with above data in Hope Collection.

Acraea amicitiae, Heron, female.

H. E.

So far as I am aware the female of this species has not been described. Two examples have lately been received by the Hope Department at Oxford from Dr. G. D. H. Carpenter. The first resembles the male in the arrangement of the markings, but the whole of the tawny-red of the male is replaced by a pale clear ochreous yellow. In this example the small discal black spots are much reduced. The spots of the fore-wing subapical band are quite transparent. On the underside the yellow colour again replaces the red of the male, and the spots and markings of the hind-wing are obsolescent.

In the second specimen the fore-wing subapical spots are also transparent. The red of the male is replaced in the cell by creamy-white, and there is a slight dusting of white scales in the middle of area 1*b*. The submarginal spot in area 1*b*, and that above it in area 2, are sepia-grey. The sepia-black ground-colour of the hind-wing is of greater extent than in the yellow-marked female or in the typical male, so that the paler markings, both discal and submarginal, which in this example are creamy-white, are much reduced. The small black discal spots of the hind-wing are, however, well developed on both surfaces, as also are the fine dark internervular lines of the underside.

Both the above females were taken by Dr. G. D. H. Carpenter, 12–14 Jan. 1928, in the Bwamba Pass, Ruwenzori, W. Uganda, at an elevation of 6500–7000 ft.

Dr. Carpenter's labels bear the notes :—" a rarity which I do not remember," " ? New to me."

Mr. Talbot informs me that a ♀ resembling the second specimen exists in the Hill Museum, and that he has seen a ♂-like ♀ in the Berlin Museum : the former from W. Kivu (*T. A. Barns*), the latter N. of L. Albert Edward, nr. Ruwenzori.

Acraea zetes, L., **rudolfi,** subsp. n.

H. E.

Examples of *Acraea zetes* collected by Dr. V. G. L. van Someren at Marsabit and Kulal, to the S.E. of Lake Rudolf, present certain features which seem to entitle them to subspecific rank. The ground-colour of both sexes is rosy-red. The fore-wing has a conspicuous submarginal row of tawny-orange spots continued nearly to the apex, and *distinctly separated* from the subapical tawny-orange patch which lies in areas 3, 4, 5, 6, and 9. The hind-wing marginal black has a submarginal row of small but distinct orange-tawny spots. In a letter to Professor Poulton Dr. van Someren states that these features are constant in a series of some fifty specimens. The females all have red ground-colour. Amongst the examples received by the Hope Department is a male from Meru (among the foothills nearly due N. of Mt. Kenya), showing a transitional stage to the typical *acara* form. In this the fore-wing submarginal spots are nearly joined to the subapical orange in areas 5 and 6.

Types : ♂, Oct., Nov. 1927 ; ♀, June 1924 ; ♂, paratype June 1924 ; from Marsabit, in Hope Coll.

Examples of this form are described by Dr. V. G. L. van Someren (1925, *J. E. Afr. Ug. Nat. Hist. Soc.*, **23** : 131), who also gives a description of the larva of *Zetes acara* and states that the Kenya examples differ from those described by Trimen (1887, *S. Afr. Butt.*, **1** : 160), the purple colour being confined to segments 4 to 9, and the others bright yellow.

Alaena subrubra, Beth.-Bak.

H. E.

Examples of this species have been received from Dr. G. D. H. Carpenter. As the males appear to differ somewhat from the hitherto unique type specimen very briefly described by Bethune-Baker, *Ann. Mag. Nat. Hist.*, (8), **16**: 186 (1915), I append a fuller description together with that of the female.

♂.—Expanse 26 to 30 mm.

Upperside. F.W. sepia-black with orange-ochreous spots. In cell a more or less discontinuous line of three spots, the basal and central ones paler than the distal. In 1*b* an elongated spot beginning at base as a mere streak and widening suddenly at about the origin of nervule 2 to a width of 1 mm., and reaching to within 2 mm. of the hind-margin. This is followed by a curved discal band of spots in 2, 3, 4, 5, 6, 9, and 10, the colour of which fades towards the costa to cream-white. Fringes ochreous, slightly blackened at nervule ends. H.W. with a black margin about 3 mm. wide, followed inwardly by a discal band of yellow. In the example I have chosen as the type this band is about 1 mm. wide from costa to area 2, where it joins a broad yellow inner-marginal mark occupying the greater part of areas 1*a*, 1*b*, and 1*c*. The cell with part of the area immediately above it is also yellow. Four other examples show various intermediate conditions from an almost entirely yellow basal and discal area to one in which this colour is broken up into spots by the dark ground-colour. The intensity of the yellow colour is also variable. Fringes as in F.W.

Underside. F.W. costa and apical area burnt-sienna. Inner margin to subcostal, orange ochreous, fading to cream-white. In cell a sub-basal and a central black mark. An irregular black mark forming a discal band in 2, 3, and 4, shading to burnt-sienna in 5, 6, 9, and 10. This followed by a band of pale colour, orange near inner margin, fading to cream-white at costa. A submarginal row of cream spots in 2 to 9, and a marginal row of the same in 2 to 7. H.W. burnt-sienna with a series of four more or less concentric rows of cream spots, one sub-basal, three discal, and one marginal. Basal cream spots in 1*a*, 1*c*, cell, and 8 and 9, and one in distal half of cell. Head black with orange collar. Thorax black and shiny. Abdomen black above and orange beneath.

♀. Expanse 36 mm.

Upperside. F.W. ground-colour orange-ochreous. Costa suffused with blackish extended into slight transverse marks sub-basally, centrally, and at end of cell. Apex broadly blackish extending to angle in a narrowing marginal border. H.W. orange ochreous with the dark portions of the underside pattern showing through slightly so as to give it a faintly chequered appearance. Margin narrowly blackish.

Underside. F.W. as above but apex and hind margin brownish-grey, with cream spots as in ♂. H.W. cream-spotted as in ♂, but ground-colour rather paler and duller. Head and body as in ♂.

3 ♂♂, 1 ♀, 1.v.27; 2 ♂♂, 2.v.27 (*Dr. G. D. H. Carpenter*) in Hope Coll. Mt. Otze, W. Madi Distr., N. Uganda.

The peculiar pattern of the underside easily distinguishes this species from any others known to me.

Alaena margaritacea, sp. n.

H. E.

♂.—Expanse 26 mm.

Upperside. Chrome-orange with black markings. F.W. base black extending beyond cell from costa to area 3, and over base of areas 2, 1*b*, and 1*a*. A small yellow spot at end

of cell. Hind margin black, not quite reaching the basal black at costa, and becoming narrower towards the inner margin. A small yellow spot in area 6 and a very minute one in 8. Fringes pale chrome dotted with black on nervules. H.W. black at base and with a broad black marginal border leaving a discal band of the ground-colour rather narrow at costa, broad in area 4, and narrowing again towards the inner margin. There is a black transverse spot at end of cell beginning at the junction of nervules 6 and 7. Fringes as in F.W.

Underside. F.W. chrome-orange, rather paler than above. Costa cream-white with black nervules and a black spot in middle and at end of cell, and one below origin of nervule 2. Apex cream-white bordered internally and externally, and divided down the middle by fine black lines. Fringes as on upperside. H.W. cream-white, rather pinkish in discal area with an irregular chequered pattern of fine black lines which in the submarginal area surround two curved and fairly regular bands, each containing six pale spots of the ground-colour. Fringes as above. Body black above with a chrome orange collar; paler beneath.

♀.—Expanse 34 mm.

Upperside. Resembles ♂, but the F.W. basal black is of much less extent leaving the cell yellow with a little black at base, a spot in the middle of cell and a transverse black mark on discocellulars. H.W. similar to that of ♂, but the black rather less dense at base.

Underside as in ♂.

Types in Hope Coll.—1 ♂, 1 ♀, 1.i.1925, with 4 ♂, 2 ♀ paratypes, 1.i.1927, Haenertzburg (*H. C. Kenway*). The species is named after the discoverer, Miss Margaret Helen Cecil Kenway, of Pretoria.

This species resembles *interposita*, Butl., but the yellow ground-colour is much richer, and the ground-colour of the ♀ is also yellow, and not white as in *interposita*. The genitalia are quite distinct from those of *interposita*.

Mimacraea marshalli, Trim., and **M. m. dohertyi,** Rothsch.

H. E.

In *Trans. Ent. Soc. Lond.*, **1924**: 152, I gave an account of the early stages of *Mimacraea marshalli dohertyi* together with a drawing of the male armature. My friend Professor Poulton has kindly handed to me a note on the armature of *marshalli* which was made for him by the late Dr. Chapman. This note was intended for communication to the Society, but was unfortunately mislaid. It is dated March 24th, 1918, and is as follows :—

"The appendages of *M. marshalli* and *M. m. dohertyi* seem to be absolutely identical, except in the matter of the size, *marshalli* being decidedly larger. This is, no doubt, a step in differentiation, but has not gone further than geographical race. In the photographs the angle on the aedeagus is obscured in *marshalli*, but is evident in the specimen and is precisely as in *dohertyi*. The two tips of the clasps look different in photographs, but this is caused by slightly different foldings in mounting.

"I take the two remarkable dorsal appendages with the globular-looking, but really helmet-shaped bases to be the falces. None of the other Lipteninae you sent me show anything at all similar."

It would appear from the above note that Dr. Chapman did not observe the asymmetry of the organs, or if he did do so, considered it not unusual. The note is not perhaps at this date of great importance, but it would be unfortunate to lose even the smallest observation by our late colleague to whose work we owe so much of our knowledge of the structure of the Lepidoptera.

Liptena diversa, Beth.-Bak., **ilala,** subsp. n.

N. D. R.

♂.—*Upperside.* Unicolorous dark brown, with the discocellular lines of underside showing through faintly.

Underside. Pale fuscous grey, both wings densely covered with fine short darker fuscous transverse striae. On the fore-wing the inner marginal area below vein 2 is devoid of striae, and area 2 is less heavily marked than the remainder of the wing surface; a single very small black dot in cell at $\frac{2}{3}$ths, and an intense black spot on discocellulars; a discal series of 5 small triangular black spots (from area 2 towards costa), between which and the submarginal series of large, dark, pale-fuscous edged crescents, lies a dark sooty-brown patch extending from costa to vein 3; resting on the pale marginal line is a series of narrow dark spots; anteciliar line black; cilia fuscous. The *hind-wing* repeats exactly the pattern of the fore-wing except that: (1) the inner marginal area is only slightly paler, (2) there are two minute or small black dots in area 1*b*, one level with the spot in the cell, the other halfway from base to margin.

♀.—Only differs from the male in having the ground-colour of the underside rather paler, and the markings lighter and more distinct.

Type ♂, Kaia River, Sudan–Uganda frontier, 16 August, 1928 (*G. D. H. Carpenter*), in Hope Coll.; Allotype ♀, Kenya Colony, Ilala, Maramas District, 14 miles E. of Mumias, 4500 ft., June 18–21, 1911 (*S. A. Neave*), in Brit. Mus.

At once distinguishable from *Liptena diversa diversa*, B.-B., by the darkened underside. Dr. Carpenter states that this butterfly "settled on bare twigs," and that the under surface was procryptic.

Liptena ilma, Hew., **daltoni,** subsp. n.

Pl. XXX, fig. 11, ♂.

E. B. P.

A series of eleven specimens (7 male, 4 female), captured 12 Feb.–1 Aug., 1915, by Dr. G. D. H. Carpenter, in thick forest, near Kakindu Hill (1° 0′ S., 31° 30′ E.), about 30 miles W. of the Victoria Nyanza, consistently differ from Hewitson's *ilma*, and from Talbot's *lathyi* described from 5 males taken in N. Kivu by T. A. Barns (1921, *Bull. Hill Mus.* **1**: 82, Pl. XIV, f. 52), in the white markings on the upper surface (absent in *ilma*, rather smaller in *lathyi*), and the almost complete suppression of the dark markings of the under surface, these latter being only represented by the central (discocellular) spot in each wing and a slight development at the apex of the F.W. Faint traces are also visible in the costal region.

The fuscous upper surface is paler in the females and the white markings larger in two out of four. Mr. Talbot informs me that a single female of *i. lathyi* was taken in Sept. 1921 by Mr. Barns in the Upper Lowa Valley, West Kivu (4500–5000 ft.), on a later expedition; also that the white area on the F.W. of this specimen is much extended, reaching the inner margin and middle of the cell, while the under surface markings, except for the central spot, are vestigial. Mr. Talbot also informs me that there is a ♂ in the Hill Museum with the white patch on F.W. obscured by fuscous. This was taken on the south side of Middle Lowa Valley, south of Walikali, 3500 ft., March 1924; forest, wet season. He suggests that it perhaps represents a reversion to the widely distributed *ilma*.

This geographical race differs from *ilma*, with its black upper surface and strong markings on the under surface, even more completely than *lathyi*, exhibiting in fact a further development of the tendency begun in this latter.

Type ♂ (Pl. XXX, fig. 11), forest near Kakindu Hill, Tang. Terr., 20 May 1915 (*G. D. H. Carpenter*), Hope Coll., O.U. Mus. Paratypes in British, Hill, Oxford and Tring Museums.

This race evidently extends into Uganda. A ♂ from W. Ankole 4500–5000 ft., 10–14 Oct. 1911 (*S. A. Neave*), exists in Brit. Mus.; and a ♂ from S. of Ft. George 3200–3400 ft., 17–19 Oct. 1911 (*S. A. N.*), in the Hill Mus.

Named after the discoverer Dr. Geoffrey Dalton Hale Carpenter, who has thrown so much light on the natural history of East African insects.

Iridana (Iridopsis) hypocala, sp. n.

Pl. XXX, fig. 6.

H. E.

♀.—Expanse. 28 mm.

Upperside. Uniform sepia-black.

Underside. F.W. sepia-black at base and over area of cell, shaded to grey along submedian area. Hind margin bears a very delicate line of silver-grey scales, bordered by a line of terra-cotta red, extending from apex to area 3. This line is separated by a fine black line from a narrow subapical band of metallic green which lies in 6, 5, and 4. The green band is followed by a slight madder-brown shading, and between this and the cell are two pale grey spots lying in areas 5 and 4. H.W. ground-colour and fringes silver-grey. A few metallic-green scales in the pre-costal area. Four discal bands of metallic green, one near base of cell, one across middle of cell, one just beyond end of cell, and one forming a curved submarginal line. Each of these metallic bands is shaded round its edges with madder-brown. The outermost or submarginal line is followed by four lines of madder-brown, silver-grey, terra-cotta red, and silver-grey respectively, the last being the fringe. Body, sepia-black.

Type ♀ in Hope Coll. Bred by Dr. R. A. L. van Someren from a larva found on a tree-trunk at Jinja, Uganda. The butterfly emerged 14 November 1923. Dr. V. van Someren is of the opinion that the larva is certainly a lichen-feeder.

Epitola katharinae, sp. n.

Pl. XXX, fig. 5 ♀, fig. 7 ♂.

E. B. P.

This interesting form was considered by my friend Mr. Bethune-Baker to be a variety of *E. dorotheae*, B.-B., with the F.W. band of the ♀ bright ochre instead of white; but when several females were received at a later date from S. Nigeria, all possessing ochreous bands, it became clear that the form is either a geographical race of *dorotheae* or a distinct species. Careful comparison with Mr. Bethune-Baker's type (♂) and other species in his rich collection now in the British Museum, led to the conclusion that the genus *Epitola* is in great need of revision based upon structural characters, and that, until this has been accomplished, it would be premature to decide upon the relationship between this new form and any other species of *Epitola*. In the meantime the following differences between it and *dorotheae*, are noted.

Male fore-wing under surface.—As compared with the ♂ type of *dorotheae* from Moyamba, Sierra Leone, the white markings on the F.W. under surface are less sharply outlined and the apices of the three Vs, which form the most conspicuous feature in the pattern, are

blunt and rounded, not sharp, as in the type. The elements of the pattern are also larger and more emphasised, especially on the H.W.

Female fore-wing upper surface.—In addition to the difference in colour—bright ochre instead of white—the F.W. band is larger in this new form, being further prolonged towards the outer margin and also especially towards the base of the wing, where the colour can be distinctly seen through a cloud of scattered brown scales.

Type ♀ from Ibadan, S. Nigeria, 30 Jun. 1924 (*A. W. J. Pomeroy*); ♂ paratype from Oni, 70 miles E. of Lagos, 16 Oct. 1911 (*W. A. Lamborn*). In Hope Coll., also many ♂ and ♀ paratypes taken by Dr. Lamborn in the same locality. Named after Mrs. Kathleen A. Pomeroy, who has kindly collected many W. African Rhopalocera for the Hope Department.

The following note by Mr. A. W. J. Pomeroy is dated 30 Jun. 1924, Ibadan, and refers to the ♀ specimen :—

"Seen to alight on a twig of a shrub near water-side. The young leaves, which are brilliant red, and twigs were covered with *Cremastogaster* ants which were eating the leaves and carrying them away. The Lycaenid proceeded to suck the sticky substance from the stem, taking no notice of the ants. The wings were first waved to and fro."

Epamera barbara,* Suffert, **toroensis,** subsp. n.

Pl. XXX, fig. 8.

N. D. R.

♂.—*Upperside* as in *E. barbara mildbraedi* ♂.

Underside differs in that the discal line on each wing is very much finer and that on the hind-wing the orange spot in area 2 is separated from the orange markings contiguous to the lobe spot,† all orange markings are reduced in size and definitely orange rather than red; the discal line is evenly curved in area 2, not as in typical *mildbraedi* W-shaped.

Holotype ♂ and one other ♂ from Uganda, Mpanga Forest, Toro, 4800 ft., 13–23.xi.1911 (*S. A. Neave*); ♂ paratype, Uganda (probably Jinja) (*V. G. L. van Someren*), in Hope Coll. (Pl. XXX, fig. 8).

Schultze did not indicate in his original description of *mildbraedi* (*Ent. Rundsch.*, **29** : 93) the exact position and direction of the discal lines of the underside. His figure published subsequently (*Ergebn. Zweit. deutsch. Zent.-Afr. Exped.*, **1**, pl. 49, fig. 11, 1925) shows them to be the same as in the

* The name *Epamera barbara*, Suffert, must not be confused with *Epamera berbera*, Beth-Bak., of which the type is in the Hope Collection and not in the British Museum as inadvertently recorded in July 1924, *Ann. Mag. Nat. Hist.*, (9) 14 : 131. The Kenya locality of *Eicochrysops rogersi* (*ibid.*, p. 134) is Kabete.

An unfortunate error in the locality of *Zeritis neriene muzizii* (*ibid.*, p. 135) is entirely my fault. The two males kindly sent to me by Dr. G. D. H. Carpenter were numbered "905," and their data should have been—"E. Madi District, N. Uganda, 2–15 Sept. 1921. In grassy country." In place of this locality I accidentally communicated to my friend Mr. Bethune-Baker the very different data of "904."

Having compared a series of the Uganda race of *Tanuetheira timon*, F., received from my friend Dr. V. G. L. van Someren, with that in *Bull. Hill Mus.*, **1**, pl. XV, fig. 74, it appeared that the two forms were of the same race or at any rate very closely allied. The figure illustrates the description (p. 90) of *Tanuetheira prometheus congoensis*, J. & T., whereas the Uganda specimens were a form of *timon*. Mr. Talbot has now informed me that *congoensis* had been inadvertently placed under *prometheus* and was, like the Uganda examples, a race of *timon*. He was, however, inclined to think that these two eastern subspecies are distinct.—E.B.P.

† In the figure on Plate XXX, these two spots are shown connected; they are quite separate in the Holotype and Paratype in the B.M.—N.D.R.

subspecies now described, with the difference that on the hind-wing the line appears to originate nearer the base. This apparent difference may be due, however, to nothing more than an artist's error in copying the shape of the apical area of the wing, which is shown less produced than is usual in this group, and to run more directly to a point nearer the lobe.

Epamera barbara is a member of an interesting little group, placed by Aurivillius (Seitz, Gross-schmett. Erde, **13**: 403) at the end of his fourth "species group" of *Iolaus* (in which he includes *Epamera*). H. H. Druce (*Trans. Ent. Soc. Lond.*, **1907**: 81) has already pointed out certain peculiarities of the male, in which this sex differs from other male Epameras, namely that it is "without the row of hairs on the inner margin of the hind-wing,* and also without the patch of differently placed scales on the shining area of the hind-wing above," but he omitted to refer to the long pale yellow patch of androconial scales situated on either side of vein 1 on the under surface of the fore-wing, a feature to which Schultze (*l.c.*) duly called attention.

There is every reason to suppose that the number of known species really present in this group, as already stated by the present writer (1928, *Nov. Zool. Tring.*, **34**: 390), is only two, viz.—

(1) *E. aethria*, Karsch (= *mirabilis*, H. H. Druce),
(2) *E. barbara*, Suffert;

the latter species having four described subspecies, viz.—*barbara*, Suff. (Cameroons, coast), *mildbraedi*, Schultze (= *yokoana*, B.-Baker, Cameroons, interior), *barnsi*, J. & T. (E. Congo) and *toroensis*. Females appear to be exceedingly rare. The present writer has described (*Nov. Zool.*, l.c.) what appears to be the female of *aethria*, Karsch, and Aurivillius (in continuation of Schultze, *l.c.*) has described the female of *E. barbara mildbraedi*; but in each of these cases only a solitary specimen was available. Unless *E. bilineata*, B.-Baker (*Proc. Zool. Soc.*, **1908**) also belongs to this group, as an examination of the Type in the Powell-Cotton collection strongly suggests, then only two females are at present known.

Epamera pollux, Auriv.

N. D. R.

Iolaus belli, Auriv. (*nec* Hew.), Seitz, Gross-schmett. Erde, **13**: 402 (see also Riley, 1928, Nov. Zool. Tring., **34**: 384, under *E. iasis*, Hew.).
Iolaus parva, B.-Baker, 1926, Ann. Mag. Nat. Hist., (9), **18**: 395.

The material in the B.M. falls into three well-defined groups, which may be distinguished as :—

(1) **E. pollux oberthueri,** subsp. n.

N. D. R.

♂♀.—Very much darker than *pollux pollux* and deeper blue without trace of green, larger.

♀.—*Upperside*, the blue colour darker, more smoky and rather less extensive than in the ♂, barely entering base of area 2, and on the hind-wing not extending above vein 4;

* No doubt the author meant *fore-wing beneath*. See also *Trans. Ent. Soc. Lond.*, **1921** (1922): 363, 364.

discal line present (on hind-wing) and the black submarginal spots in 1*c* and 2 very large, the former surmounted by a white spot and then a smaller black one.

♂♀.—*Underside*, as in *pollux pollux*.

Hab. Ivory Coast, 6 ♂♂, 3 ♀♀ in B.M., including Types.

(2) **E. pollux pollux**, Auriv.

N. D. R.

Two females from S. Nigeria are devoid of discal lines on the upperside. *I. parva*, B.-Baker, was described from a typical ♂ from the Cameroons.

(3) **E. pollux albocaerulea**, subsp. n.

Pl. XXX, fig. 10.

N. D. R.

♂.—*Upperside*, on the fore-wing the light sky-blue faintly greenish area completely fills the cell, occupies the basal third of area 3, half area 2 and reaches to 1·75 mm. from margin in 1*b*; on the hind-wing it extends to some extent above vein 6; lobe orange (rather than red) and black, the orange spot rather prominent.

♀.—*Upperside*, black areas as in ♂; the median area white; the basal half of cell and a long tongue running along vein 1 as far as the black margin lilacine-blue. Hind-wing white; a quadrate black apical spot and black marginal and anteciliar lines; the white suffused (except in costal area) unevenly with lilacine-blue which deepens towards the base.

♂♀.—*Underside*, as in *pollux pollux* except that the red and orange markings on the hind-wing are considerably paler and less extensive.

Hab. Uganda, Tero Forest, S. E. Buddu, 3800 ft., 26–30.ix.1910 (*S. A. Neave*), 6 ♂♂ (including holotype). Between Jinja and Busia or Mbwago's, E. Busoga, some forest, 3800–4000 ft., 28.vii.–1.viii.1911 (*S. A. Neave*), 1 ♀, allotype; all in Brit. Mus. 1 ♂ paratype, Uganda (probably Jinja) (*V. G. L. van Someren*); in the Hope Coll. (Pl. XXX, fig. 10).

The differences between the females in these three races are most striking.

Eicochrysops dudgeoni, n. sp.

Pl. XXX, fig. 2 ♂ underside, fig. 4 ♂ upperside.

N. D. R.

♂.—*Upperside* deep blue with a wide dyslegnic black border (2 mm.) to both wings, broadening somewhat at apex of fore-wing and continued thence narrowly along costa to base. Cilia of both wings dark grey-brown. Hind-wing with an intensely black ovoid marginal spot in area 2 resting on a pale grey line and surmounted by a red crescent, the whole just contained within the black border; the pale grey line continued, much more narrowly, and broken by the veins on either side, to the anal angle and to the apex.

Underside dull grey, both wings with a darker white-edged line at cell-end, a very fine black anteciliar line and dull grey cilia; no basal spots. Fore-wing with a discal series of 6 separated, rounded, dark spots, in area 1*a*–6, white-edged, progressively smaller from inner margin to costa, midway between cell-end and termen, but converging towards termen posteriorly; a submarginal series of chevron-shaped dark spots, bordered both sides with white in areas 2–6, but fading rather towards apex, and represented in 1*a* by only a white line in a dark area; a series of 5 dark marginal triangles; a white

marginal line broken by the veins. Hind-wing discal spots rectangular, conjoined between veins 1*b* and 6, echeloned outwardly from vein 3 to vein 6, the spot in area 6 removed considerably basad, that in 7 still further towards base and very faint, the two last mentioned less rectangular than the others, all white-edged; the chevrons of the submarginal series (inverted in 1c) only obvious in areas 3–6, where their inner white borders are fused with the outer white borders of the discal spots; marginal triangles (not sharply triangular) in 3–6, and faint (almost linear) in 1*c*; an intensely black, round marginal spot in 2, very narrowly edged inwardly with metallic mauve, and surmounted by a relatively large orange-red crescent that spreads across veins 2 and 3 so as slightly to invade the adjoining cells; marginal triangles (and black spot in 2) separated from anteciliar line by a comparatively wide line of white.

♀.—Exactly like the male except that the blue arc of the upperside of that sex is entirely replaced by black.

Length of fore-wing 10 mm.

Described from a series of 8 ♂♂, 3 ♀♀, from Nigeria, viz :—Zaria Province, May 1909 (*G. C. Dudgeon*), Holotype ♂ and 1 Paratype ♂ (in B.M.); Kaduna, the Capital of N. Nigeria, 11.viii.24 (*Mr. and Mrs. A. W. J. Pomeroy*), Allotype ♀, 3 ♂ Paratypes, 1 ♀ Paratype and 2 ♂♂ (Hope Coll.), 1 ♀ Paratype (B.M.); 11.ix.24, 2 ♂ Paratypes (Hope Coll.).*

The entire absence of basal spots on the underside of either wing serves at once to distinguish this little species from the other included in *Eicochrysops*, by which name Bethune-Baker distinguishes the eighteenth group of Aurivillius' *Cupido* (Seitz, Gross-schmett. Erde, **13:** 487). This same feature, however, renders it impossible to run down the species correctly by the key given by the latter author (*loc. cit.*, p. 457), as it would place it in the group composed of the genera *Nacaduba*, *Lampides*, *Cyclyrius* and *Brephidium*, with which it is by no means closely related. Superficially *E. dudgeoni* resembles *E. messapus*, Godt, in the coloration of the upperside in the ♂, but the wide black borders of both wings, and the distinctly more convex fore-wing termen, separate it at a glance.

Pinacopteryx liliana, Gr.-Sm., **pulverulenta,** subsp. n.

F. A. Dixey.

[We are indebted to the kindness of Dr. F. A. Dixey for the description of this interesting subspecies.]

Among the Pierines collected by Dr. V. G. L. van Someren at Kulal to the S. of Lake Rudolf in November and December, 1927, there is a dry-season pair, ♂ and ♀, of a *Pinacopteryx* which differs in some respects from any forms of the genus known to me. A series including the wet-season form would no doubt remove uncertainty as to its exact status. Meanwhile it may be allowable to describe this *Pinacopteryx* as a subspecies of *P. liliana*.

♂. Exp. al. 44 m. *Upperside* white; costal margin of fore-wing slightly edged with a sprinkling of dark scales merging at the apical angle of the wing into a thin border, which is continued along the posterior margin as a chain of dark spots at the distal extremities of the veins, diminishing in size and becoming more separate from before backwards. A minute discocellular spot is present. Hind-wing; white like the fore-wing, the veins

* Since this description was written 14 ♂♂ have been received by the Hope Dept., taken 3 May, 1928, by Mrs. K. A. Pomeroy on the Gambaga Escarpment (about 500 ft.) N. Territories, Gold Coast.—E.B.P.

terminated distally with extremely minute dark points. No discocellular spot. There is a slight dusting of dark scales at the base of both fore- and hind-wing. Beneath: the ground-colour of the fore-wings is white, with the exception of the apex and a band diminishing in breadth as it is prolonged backwards from the apex along the posterior margin; these areas share in the colouring of the hind-wing. There is a conspicuous dark spot between the second and third branches of the median, and a discocellular spot somewhat larger than that of the upper surface. The ground-colour of the hind-wing and of the corresponding area of the fore-wing is creamy, and in both situations it is thickly overspread with a powdering of greyish-brown scales in irregular patches, giving the suggestion of an accumulation of dust. The position of a discocellular spot, and also of a submarginal row on the hind-wing and the apical area of the fore-wing respectively are in each case indicated by a few darker scales.

♀. Exp. al. 54 m. *Upperside* like that of the male, except that the dark apex and posterior border of the fore-wing are broader, and that the spots forming the latter are more completely fused. There is also an indication of the anterior three members of a submarginal dark series; the discocellular spot is larger than in the male, and there is a conspicuous dark spot between the second and third median branches. The hind-wing has no discocellular spot, and the distal spots of the veins are larger than in the male. The resemblance of the underside to that of the male is close. There is, as in that sex, a dark median spot on the fore-wing. The mottling of the hind-wing and apical area of the fore-wing is similar to that in the male, but the ground-colour of these areas being of a somewhat deeper yellow, the dusty appearance is rather less conspicuous, though the indications of a submarginal row in both wings, and the discocellular spot in the hind-wing, are more distinct than in the male. The discocellular spot of the fore-wing is like that of the upper surface.

Type ♀, and paratype ♂, both from Mt. Kulal, N.N.W. of Mt. Marsabit and towards the S. of Lake Rudolf; Nov., Dec., 1927. In Hope Coll. Oxford Univ. Museum.

The conspicuous mottling of the under surface in this form at once suggests the dry-season phase of *P. charina*, Boisd., the species of this group that occurs from Cape Colony to the Transvaal. An examination of the genitalia of the male, a preparation of which was kindly made for me by my friend Dr. Eltringham, shows also a much closer correspondence with *P. charina* from the south than with *P. simana*, Hopff., and *P. venata*, Butl., species whose distribution is much nearer to that of the present form. But these organs in Van Someren's male specimen accord pretty closely with the same structures in *P. liliana*, Gr.-Smith; and the scent-scales of the same specimen are, with slight differences, clearly of the same character as those of *P. liliana*, the form of the *charina* group which is characteristic of the neighbourhood of Mombasa. Dry-season specimens of the latter may show a slight almost imperceptible mottling of the under surface; but I know of no specimen in which the under surface at all recalls that of the present examples.

It has been pointed out in a paper on the *charina* Group of *Pinacopteryx* (*Trans. Ent. Soc. Lond.*, **1918**: 191–208) that the border-line between the various geographical forms of that Group is often not easily to be defined; but if the points of difference from typical *P. liliana* should turn out to be constant, there seems to be no reason why the Lake Rudolf *Pinacopteryx* should not take rank as a local race or subspecies of that insect.

Dr. van Someren's collection contains a single male specimen of a *Teracolus* from Kulal which resembles in most respects *T. ocellatus*, Butl., of which there

is one specimen, the type, a male from Somaliland, in the collection of the British Museum. The present specimen, like the type, has a pale centre to the discocellular spot (hence "ocellatus"); it differs from the type in having the whole ground-colour of the hind-wings salmon-pink like that of the fore-wings. In the type, the salmon-pink of the hind-wings occupies only one-third of the ground-colour; the rest being bluish-grey, like the inner area in *T. protractus*, Butl.

The collection of the British Museum also contains a large male, the type and only specimen of a form labelled *T. phisadia* f. *vagus*, Riley. It is like typical *T. phisadia*, Godt.; except that the whole ground-colour of the hind-wings is salmon-pink with a slight bluish-grey shade at the inner border, and that the inner edge of the black border of the hind-wing is quite differently shaped. There is no pale centre to the discocellular spot. The pin-labels say "Locality very doubtful." "East Africa. New Moschi. 19 March 1916. F. C. Selous." The Kulal specimen is thus intermediate in some respects between the *ocellatus* and *vagus* forms, the fore-wing resembling that of the former; the hind-wing that of the latter.

Some examples of *T. rothschildi*, E. M. Sharpe (Mombasa), have a slight touch of salmon-pink along the outer border of the hind-wing. The salmon-pink in *T. rothschildi* is paler than in *T. protractus* and *T. phisadia*.

Van Someren's series from Kulal also contains a male specimen of *T. heliocaustus*, Butl., a form characteristic of Somaliland.

Two new female forms of *Papilio dardanus*, Brown, with notes on other male and female forms of the same species.

E. B. P.

Papilio dardanus, Brown, ♀-f. n. **swynnertoni.**

The northern female resembling *leighi*, at present known as a ♀-f. of *d. dardanus* in Uganda and of *d. polytrophus* in Kenya Colony, is distinguished from the southern ♀-f. by the tint of the F.W. markings. These are tawny orange, differing from the more golden chrome of the southern ♀, which resembles in tint (but by no means in pattern) the Abyssinian ♀-f. *wienholti*, Poult., as was pointed out in the description of this latter (1927, *Proc. Ent. Soc. Lond.*, **2**: 10). The differences between *leighi* and this northern ♀-f. were also carefully considered in the description of the former (*ibid.*, **1911**: xxxviii–xlii), to which Roland Trimen contributed a valuable note. The new ♀-f. was first described and figured as a "♀ *form intermediate between* cenea, *and* planemoides" by the present writer in *Trans. Ent. Soc. Lond.*, **1906**: 293, 294, Pl. XX, fig. 1.

Type. The ♀-f. referred to above, from Unyori (Nyangori), N.E. of Kisumu (about 1903), ex Coll. A. H. Harrison. In Hope Coll., with paratypes from Uganda and Kenya Colony.

It is a pleasure to associate the name of my friend Mr. C. F. M. Swynnerton with a form of *dardanus*—all the more so because I had hoped (but delayed too long) to name the ♀-f. *natalica*, le Cerf, after him. Mr. Swynnerton's success in breeding this latter in S.E. Rhodesia is referred to on p. 502.

Papilio dardanus, Brown, ♀-f. n. **carpenteri.**

Pl. XXXI, fig. 1.

The inability to carry out my intention of naming the *natalica* ♀-f. after Mr. Swynnerton leads me to delay no longer but at once dedicate the interesting

female described in *Proc. Ent. Soc. Lond.*, **1915**: lxxxvi, lxxxvii, to Dr. G. D. H. Carpenter, who succeeded in breeding from it the female forms *trophonissa*, Auriv., and *planemoides*, Trim., thus supporting the conclusion founded on its pattern, that the parent was a heterozygote combining these two forms.* The hybrids between some female forms of *dardanus* (one female form being carried by the male parent) are often extremely variable, producing a transitional series of which it would be inappropriate to name each separate step; but this particular hybrid is a fairly constant form, appearing from time to time in an area where both the female patterns are well known to occur, viz. in Uganda and Tanganyika Territory immediately to the south of it. It is unnecessary to add to the description published in 1915, and all the more so because the appearance of this ♀-f. is clearly represented slightly under natural size on Pl. XXXI, fig. 1, together with that of its two female (figs. 3, 4), and one of its male offspring (fig. 2). It should be added that in other examples of this form, although the pattern as a whole is similar to the figure, the patterns of *trophonissa* and *planemoides* are less readily detected, the fusion being more complete.

Type. The ♀ (Pl. XXXI, fig. 1) captured by Dr. Carpenter in the forest near Kakindu Hill (25 Apr. 1915), Tang. Terr., in lat. 1° 10′ S., long. 31° 30′ E., about 30 miles W. of the Victoria Nyanza. In Hope Coll., with paratypes from Kakindu and Uganda.

Notes on male and female forms of *Papilio dardanus dardanus*, Brown.

A valuable paper by M. Fd. le Cerf, published in the *Bull. Hill Mus.*, **1**: 369, Pls. I–V, 1924, contains descriptions of or remarks upon the following forms of *dardanus*, with figures of those newly described as well as of Suffert's types now in the Hill Museum at Witley. Naturalists are much indebted to the author for describing these forms and to Mr. Joicey for figuring the types. It is a great comfort to be enabled to determine on this solid evidence the precise position of the forms named by Suffert in the long series of intergrading patterns presented by the females of *dardanus*. A few comments on these and the other forms described in the paper may not be out of place.

The ♀-f. *hippocoon*, F.—Suffert's type of *heimsi* (p. 373, Pl. I, fig. 2), a rare modification of the *hippocoon* pattern, is shown to be characterised not only by the enlarged white area and diminished black border of the hind-wing, but also by the extension of the chief white mark of the fore-wing into the lower part of the cell and above vein 3, the pattern being that of *trophonissa*, Auriv., although the tints are those of *hippocoon*. The type is from Cameroon, but a remarkable female from Nairobi, presented by Canon Rogers to the Hope Collection, has a very similar extension of the white elements, and is further characterised by the cloudy (dyslegnic) boundaries between these and the surrounding black.

The ♀-f. *cenea*, Stoll.—Suffert's type of *acene* from the Transvaal (p. 377, Pl. II, fig. 19) is shown to possess traces of a yellowish tint in the oval discal spot in area 2 of the fore-wing, which is therefore not wholly white-spotted, as is generally assumed.

M. le Cerf also describes and figures three new forms of *cenea* :—(1) *ceneispila*,

* See Carpenter, *A Naturalist in East Africa*, p. 42, Pl. III, Oxford, 1925.

from Uganda (p. 374, Pl. II, fig. 11); (2) *acenides*, from the Mabira Forest, Uganda (p. 375, Pl. II, fig. 16); (3) *hypolimnides*, from West Pondoland (p. 377, Pl. II, fig. 13). The author considers that the last form recalls in its pattern and tints certain varieties of *Hypolimnas dubia*, Beauv., evidently of the form *mima*, Trim.

♀-f. *planemoides*, Trim. (p. 374).—M. le Cerf considers that Trimen and Aurivillius are mistaken in assigning this female form to the race *merope*, Cram., and the present writer in assigning it to *polytrophus*, Jord. He himself correctly places it with *dardanus dardanus*, Brown, but incorrectly implies that it does not exist in other races. Trimen in assigning it to *merope*, Cram., was using this name for *dardanus*, as he did in his classical memoir (1870 (1869), *Trans. Linn. Soc. Lond.*, **26**: 497), and was not referring to any of the geographical races, but to the species as a whole. The localities given by him for the two examples he described (*Proc. Ent. Soc. Lond.*, **1903**: xxxviii–xli; not in *Proc. Zool. Soc.* as given by le Cerf) are, as le Cerf states, those of the race *dardanus dardanus*, viz. the type, taken about 1903, at Tiriki (about 5500 ft), on the Nandi Escarpment in E. Kavirondo, by Mr. C. W. Hobley and presented by him to the Hope Collection, which also contains Trimen's second example, the paratype, labelled "Angola; Rogers, 1873." Furthermore, Aurivillius did not place this form with "the race *merope*," but with *polytrophus*, and quite correctly, for specimens of *planemoides* from the Kikuyu Escarpment exist in the Tring Museum and from Nairobi in the Hope Collection. It has also been taken by Canon Rogers well in the area of *tibullus* (*Proc. Ent. Soc. Lond.*, **1911**: xlii), so that *planemoides* is known to be present as a ♀-f. in all the races of *dardanus* except *antinorii*, Oberth., and *cenea*, being represented by *leighi* in this last subspecies.

♀-f. *leighi*, Poult. (p. 378, Pl. II, fig. 12).—The figured specimen is from West Pondoland. This form is not so rare as M. le Cerf believes. A fair number of specimens have been bred and captured, especially by G. F. Leigh, in Natal. Two examples in the Durban Museum, one of them bred by Mr. Leigh, were described and figured in 1917, *Ann. Durban Mus.*, **2**, by Mr. C. N. Barker.

♀-f. *natalica*, le Cerf (p. 377, Pl. II, fig. 17), from Delagoa Bay, is described as possessing the pattern of *hippocoonoides*, Haase, but with all the pale areas of an ochreous tint. The type is in the Trimen Collection, now in the Hill Museum, and had been placed by Trimen as one of certain "examples leading from the first form *hippocoon* to the form *trophonius*, Westw.," and described by him in *Proc. Ent. Soc. Lond.*, **1911**: xli, xlii. M. le Cerf quotes the last form name as *trophonissa*, but this latter was described by Aurivillius, not by Westwood, and belongs to the Western and Uganda race *dardanus dardanus*. The author considers that *natalica* is an ancestral form comparable with *trimeni*, Poult., but the dark bar crossing the fore-wing, so far from becoming evanescent or weak, as in this last form, is broad and strongly marked. Specimens of *natalica* from S.E. Rhodesia in the Hope Collection show a considerable range of variation in the direction of *cenea* and especially of *leighi*. Although variable, the form *natalica* breeds true, as C. F. M. Swynnerton proved in 1913, rearing 5 of these females and 2 *hippocoonoides* from a *natalica* female captured at Chirinda, S.E. Rhodesia (*Proc. Ent. Soc. Lond.*, **1914**: lxii, lxiii, Fam. D), where this form is spoken of as "*leighi*-like" and briefly described. A form which is evidently the ♀-f. *natalica* is also described and figured in an interesting paper by C. N. Barker (Dec. 1917, *Ann. Durban Mus.*, **2**: 37, Pl. VII, fig. 15). Two examples of a ♀-f. which is certainly *leighi* are described on the same page (37) and represented in figs. 13 and 14. The author points out that the only

form known to him " in which the coloration of the two wings affords similar contrasts is *dardanus planemoides*."

The name *natalica* is not very appropriate, for although the form occurs in Natal, it is by no means restricted to this country, and M. le Cerf has himself chosen a specimen from Delagoa Bay as the type.

♀-f. *dionysoides*, Auriv. (p. 375).—This female form name is quoted as Hewitson's, but it was given by Aurivillius to a *trimeni*-like female in which the bar crossing the fore-wing, instead of being evanescent, is altogether wanting, as in *dionysos*, Dbl. & Hew. Mr. Talbot informs me that the "*dionysoides*" from Warri (Nigeria) in the Hill Museum is typical *dionysos* such as is figured in Doubleday's *Gen. Diurn. Lep.*, pl. 3, fig. 4. It is to be noted, however, that a *dionysos* with the fore-wing bar well developed is figured by Hewitson (*Exot. Butt.*, IV, Papilio, XII, fig. 39). Trimen refers to this figure in *Trans. Ent. Soc. Lond.*, **1874:** 148, also in *Proc. Ent. Soc. Lond.*, **1897:** lxxxviii, footnote, where he concludes that the female is intermediate between *dionysos* and *hippocoon*, but nearer to the latter.

In addition to the above-named female forms M. le Cerf throws valuable light on named forms of the male.

♂-f. *boosi*, Suff. (p. 375).—The author concludes that this name should be restricted to those males of *polytrophus* which possess a series of small yellow spots in the black margin of the fore-wing, and that Suffert's locality—Dar es Salaam—is erroneous. Aurivillius (in Seitz) appears to have reached the same conclusion, for he sinks *boosi* as a synonym of *polytrophus*. This small variation of the male pattern is certainly hereditary, as it appears in several males in the same family, bred by Dr. V. G. L. van Someren at Nairobi, and now in the Hope Collection; also in three males captured (1903–04) in the same locality by E. A. Elliott and showing various degrees in the development of these spots, and in a beautiful example, taken 27 Nov. 1919, at Nairobi, by Canon St. Aubyn Rogers.

♂-f. *maculatus*, Suff. (p. 376, Pl. I, fig. 8).—The figured type, from Tanganyika Territory, is a characteristic male of *tibullus*, Kirb., with a series of spots like those of *boosi*. It is, in fact, the *boosi* form of the male *tibullus* (quoted as *cenea* by M. le Cerf), and in my opinion should be regarded as a synonym of *boosi*,—described and figured in *Iris*, XVII, 1904, p. 82, whereas *maculatus* is described on a later page (91) of the same publication. If *maculatus* be retained as a form name then additional names will be required for the *boosi*-like varieties of *d. cenea* and *d. dardanus*; for they are known, as M. le Cerf shows, in the areas of both these races as well as of *polytrophus* and *tibullus*.

♂-f. *discopunctatus*, Suff. (p. 376, Pl. I, fig. 10).—The figured type from Usambara is an unusually dark male of *d. tibullus*, here also named *d. cenea* by M. le Cerf. The author describes this variety—characterised by the peripheral end of the fore-wing cell being emphasised by black pigment—as common in East Africa, and it is therefore probably to be found in the area of *cenea* to the south as well as *tibullus* to the north. The dark markings of the hind-wing have in the figured specimen so far encroached on the pale yellow ground-colour as to support the conclusion that the submarginal spots of the mimetic females are also the vestiges of ground-colour still more reduced by further encroachment.

♂-*f. extensiflava*, le Cerf (p. 378, Pl. I, fig. 9).—The figured type was bred in 1917 by G. F. Leigh in Natal and therefore from the area of *d. cenea*. It is characterised by the fusion of the subapical spot of the fore-wing with the pale

ground-colour; also by the extremely narrow black margin of the fore-wing. M. le Cerf has found, in the Hill and Paris Museums, less pronounced variations of the same kind in males from the areas of other races of *dardanus* and also from Madagascar. Three variations in the direction of *extensiflava*, taken (1903–04) in the Nairobi district by E. A. Elliott, exist in the Hope Collection, together with three males exhibiting a similar tendency, bred in one family at Nairobi by Canon K. St. Aubyn Rogers.

Gorgyra bibulus, sp. n.

N. D. R.

♂♀.—With the structural characters of the genus, but all four wings uniformly very dark brown, almost black and entirely devoid of translucent spots, on both upper and lower surfaces. On the underside there are, however, a few scattered pearly greyish scales.

The palpi, as seen from above are black, with a few orange hairs. The antennae black, minutely dotted with white along the shaft at each joint, and with the distal half of the club below and on the same side as the crook shining white. The head is also black as seen from above, but has a somewhat stronger admixture of bright orange hairs; the frons distinctly paler. Seen from beneath the palpi (except the tip of the third segment) and the anterior portion of the thorax, between the legs, are bright rufous orange.

Length of fore-wing 13–14 mm.

Hab. Kenya Colony. 1 ♂ (Allotype) Koinangis, about 15 miles N.N.W. of Nairobi, 7000 ft., 9.ix.1919 (*St. A. Rogers*); 1 ♂ (Paratype) S.W. slopes of Mt. Kenya, 6000 ft., 14.ix.1911 (*St. A. Rogers*), in Hope Coll.; 1 ♀ (Holotype) S.E. slopes of Mt. Kenya, 6–7000 ft., 3–12.ii.1911 (*S. A. Neave*) Coll. Brit. Mus.

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AFRICAN BUTTERFLIES.

Parent.

1

2

3

4

Alfred Robinson, Phot.

All the figures are slightly under natural size.

Fig. 1, Parent (*Pap. dardanus* ♀ -f. *carpenteri*) with 1 of the 5 ♂ offspring (Fig. 2), and both ♀ offspring—*trophonissa* (Fig. 3) and *planemoides* (Fig. 4).

Explanation of Plate XXX.

All the figures are of the natural size.

Fig. 1. *Euxanthe trajanus*, Ward, n. ssp. *vansomereni*, ♀, from Mawakota, 80 m. W. of Kampala, Uganda (Apr. 1924), (*V. G. L. van Someren*). Paratype. E.B.P.

2. *Eicochrysops dudgeoni*, n. sp., ♂ (under surface), from Zaria Prov., Nigeria, (May 1909), (*G. C. Dudgeon*). Paratype. N.D.R.

3. *Pseudacraea eurytus*, L., n. f. *victoris*, ♀ (under surface L., upper R.), from Mt. Marsabit, S.E. of Lake Rudolph (July 1923), (*V. G. L. van Someren*). Type. H.E.

4. *Eicochrysops dudgeoni*, n. sp., ♂ (upper surface), data as in fig. 2. Type. N.D.R.

5. *Epitola katharinae*, n. sp., ♀ (under s. L., upper R.), from Ibadan, S. Nigeria (30 Jan. 1924), (*A. W. J. Pomeroy*). Type. E.B.P.

6. *Iridana* (*Iridopsis*) *hypocala*, n. sp., ♀ (under s. L., upper R.), bred, 14 Nov. 1923, from larva at Jinja, Uganda (*R. A. L. van Someren*). Type. H.E.

7. *Epitola katharinae*, n. sp., ♂ (under s. L., upper R.), from Oni, 70 m. E. of Lagos (16 Oct. 1911), (*W. A. Lamborn*). Paratype. E.B.P.

8. *Epitola barbara*, Suff., n. ssp. *toroensis*, ♂ (under s. L., upper R.), from Uganda, probably Jinja (*V. G. L. van Someren*). Paratype. N.D.R.

9. *Neptis roberti*, n. sp., ♀ (under s. L., upper R.), from Mulange, Mabira Forest (3400 ft.), Uganda (Jan. 1922), (*R. A. L. van Someren*). Type. H.E.

10. *Epamera pollux albocaerulea*, n. ssp., ♂ (under s. L., upper R.), from Uganda, probably Jinja, (*V. G. L. van Someren*). Paratype. N.D.R.

11. *Liptena ilma*, Hew., n. ssp. *daltoni*, ♂ (under s. L., upper R.), from forest near Kakindu Hill (1° 0′ S., 31° 30′ E.), Tang. Terr. (20 May 1915), (*G. D. H. Carpenter*). Type. E.B.P.

Explanation of Plate XXXI.

All the figures are slightly under the natural size.

Fig. 1. *Papilio dardanus dardanus*, Brown, n. ♀-f. *carpenteri*, taken in thick forest near Kakindu Hill (1° 0′ S., 31° 30′ E.) Tang. Terr., 25 Apr. 1915 (*G. D. H. Carpenter*). Type. E.B.P.
The figure represents the parent of the ♂ (fig. 2) and the two females (figs. 3 and 4). Ova were laid about 26 April, hatched 3–4 May, 1915.

2. ♂ *P. d. dardanus*. Pupation 7 June, emergence 28 June. One of the 5 ♂ offspring of ♀ (fig. 1)—1 deformed, 3 resembling fig. 2.

3. ♀ *P. d. dardanus*, ♀-f. *trophonissa*, Auriv. Pupation 8 June, emergence 26 June. One of the 2 ♀ offspring of ♀ (fig. 1).

4. ♀ *P. d. dardanus*, ♀-f. *planemoides*, Trim. Pupation 9 June, emergence 28 June. One of the 2 ♀ offspring of ♀ (fig. 1).

These two female offspring and another female from Kakindu resembling the parent, are represented on Pl. III of Dr. Carpenter's *Naturalist in East Africa*, Oxford, 1925, and referred to on p. 42.

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